

DRAFT 2017

Guam Marine Conservation Plan



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1. INTRODUCTION

The U.S. Public Law 94-265 established the Magnuson-Stevens Fishery Conservation and Management Act (MSA) to serve as the primary law governing marine fisheries management in United States federal waters. Section 204(e) of the MSA authorizes the Secretary of State, with the concurrence of the Secretary of Commerce (Secretary) and in consultation with the Western Pacific Regional Fishery Management Council (Council), to negotiate and enter into a Pacific Insular Area Fishery Agreement (PIAFA). A PIAFA would allow foreign fishing within the 200-mile U.S. Exclusive Economic Zone (EEZ) adjacent to Guam with the concurrence of, and in consultation with, the Governor of Guam. Before entering into a PIAFA, the appropriate Guam Governor, with the concurrence of the Council, must develop a 3-year Marine Conservation Plan (MCP) providing details on uses for any funds collected by the Secretary under the PIAFA.

In addition to PIAFA funds, the MSA provides that fines and penalties of violations by foreign vessels occurring within the EEZ around Guam, including sums collected from forfeiture and disposition or sale of property seized by the federal government, are to be deposited into the Government of Guam's Treasury and to be used to implement the Guam MCP. Also authorized by the MSA is the Western Pacific Sustainable Fisheries Fund, which allows the Council to use funds to implement projects contained in this MCP.

The MSA requires that the MCP shall be consistent with the Council's Fishery Ecosystem Plan (FEP) for the Mariana Archipelago and the Fishery Ecosystem Plan for Pacific Pelagic Fisheries. The MSA also requires that the MCP include, but not limited to, the following conservation and management objectives:

- (i) Pacific Insular Area observer programs, or other monitoring programs, that the Secretary determines are adequate to monitor the harvest, bycatch, and compliance with the laws of the United States by foreign fishing vessels that fish under Pacific Insular Area fishing agreements;
- (ii) Conduct of marine and fisheries research, including development of systems for information collection, analysis, evaluation, and reporting;
- (iii) Conservation, education, and enforcement activities related to marine and coastal management, such as living marine resource assessments, habitat monitoring and coastal studies;
- (iv) Education and training in the development and implementation of sustainable marine resources development projects, scientific research, and conservation strategies; and
- (v) Western Pacific community-based demonstration projects under section 112(b) of the Sustainable Fisheries Act and other coastal improvement projects to foster and promote the management, conservation, and economic enhancement of the Pacific Insular Areas.

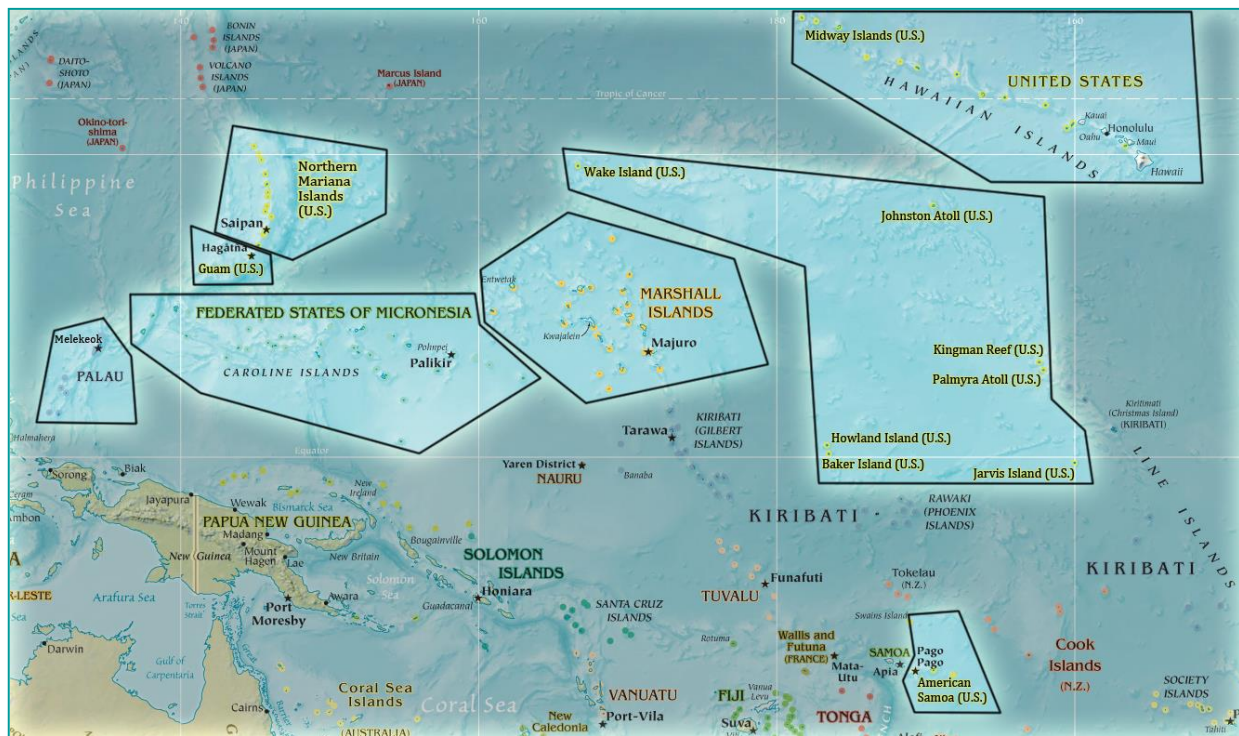


Figure 1

The Pacific Insular Areas include American Samoa, Guam, the Northern Mariana Islands (NMI), Baker Island, Howland Island, Jarvis Island, Johnson Atoll, Kingman Reef, Midway Island, Wake Island, and all islands and reefs adjacent to any of the above (Figure 1).

Guam has an Exclusive Economic Zone (EEZ) of around 84,170 square miles, while having a land area of around 212 square miles. Guam's EEZ borders the Federated States of Micronesia (FSM), 100 miles to the south, and the Commonwealth of the Northern Mariana Islands, 20 miles to the north, with around 25 percent of the EEZ bordering international waters.

The dynamic nature of the tuna fishing industry in the central and western Pacific and complexity of regional and subregional fisheries management and development issues present challenges for the development of a long-term plan. The three-year time frame of the MCP provides an opportunity for periodic evaluation and adjustment of programs and projects as new issues and prospects develop. This plan demonstrates that there are extensive opportunities to pursue marine conservation and development activities in the EEZ around Guam. However, the quantity and timing of the funds available for implementation of the MCP is uncertain, and, as such, the ability to capitalize on these opportunities should be cast with reasonable expectations.

Objectives of the Mariana Archipelago FEP and Pelagic FEP

The following lists the objectives of the Mariana Archipelago and Pelagic Fishery Ecosystem Plans (FEP), which were approved by NMFS in 2009.

- Objective 1:* To maintain biologically diverse and productive marine ecosystems and foster the long-term sustainable use of marine resources in an ecologically and culturally sensitive manner through the use of a science-based ecosystem approach to resource management.
- Objective 2:* To provide flexible and adaptive management systems that can rapidly address new scientific information and changes in environmental conditions or human use patterns.
- Objective 3:* To improve public and government awareness and understanding of the marine environment in order to reduce unsustainable human impacts and foster support for responsible stewardship.
- Objective 4:* To encourage and provide for the sustained and substantive participation of local communities in the exploration, development, conservation, and management of marine resources.
- Objective 5:* To minimize fishery bycatch and waste to the extent practicable.
- Objective 6:* To manage and co-manage protected species, protected habitats, and protected areas.
- Objective 7:* To promote the safety of human life at sea.
- Objective 8:* To encourage and support appropriate compliance and enforcement with all applicable local and federal fishery regulations.
- Objective 9:* To increase collaboration with domestic and foreign regional fishery management and other governmental and nongovernmental organizations, communities, and the public at large to successfully manage marine ecosystems.
- Objective 10:* To improve the quantity and quality of available information to support marine ecosystem management.

2. MARINE CONSERVATION PLAN

2.1 Overview of the MCP

This document is Guam's Marine Conservation Plan (MCP) and describes how the Governor of Guam proposes to allocate funds obtained under a PIAFA or collected from fisheries violations within the Guam EEZ for the period 2017-2020. The document provides information on the process by which the MCP was developed and reviewed, the programmatic objectives that were

determined to be funding priorities and the project activities to be undertaken. Given the uncertainty of the quantity and timing of the funds available for implementation of the MCP, this plan should be viewed as a working document subject to periodic review and revision.

To avoid duplicating existing marine conservation programs and projects in Guam, activities being pursued under the Guam Fisheries Development and Management Plan, Guam's Coral Reef Initiative, Guam's Coral Reef Conservation Program, Guam's Comprehensive Economic Development Plan and the Port Authority of Guam Master Plan were considered.

The MCP, in certain instances, calls for the initiation or continuation of activities complementary to existing programs/projects. These complementary programs may be conducted in conjunction with the Council, National Marine Fisheries Service (NMFS), local or Micronesian-based entities or with regional marine resource conservation, development or management organizations.

The MCP is consistent with the Council's fishery ecosystem plans. The plan contains conservation and management objectives including criteria for determining when such objectives have been met as well as prioritize planned projects.

2.2 MCP Objectives

The Guam MCP contains six conservation and management objectives under which planned projects and activities designed to meet the objective are identified and described, as follows:

Objective 1. Fisheries Resource Assessment, Research and Monitoring

1. Continue long-term assessment and monitoring of Guam coral reef flat communities, monitoring of coral health; and coral community ecology monitoring.
2. Collection and tagging of near-shore reef fish to provide quantitative assessment of the impact of fishing in Guam's coastal zone.
3. Develop and print voluntary catch logs and data collection to assess impacts on current and proposed regulations upon fisheries, fishermen and fishing communities.

Objective 2. Effective Surveillance and Enforcement Mechanisms

1. Implementation of an at-sea observer program to collect information on foreign fishing activities.
2. Increase enforcement and surveillance of the U.S. EEZ around Guam.

Objective 3. Promote Ecosystems Approach to Fisheries Management, Climate Change Adaptation and Mitigation, and Regional Cooperation

1. Develop a permit, reporting and/or quota transferability program to utilize Guam's quota allocations established under the WCPFC.

Objective 4. Public Participation, Education and Outreach, and Local Capacity Building

1. Development and distribution of public information materials promoting sustainable use of ocean resources.

Objective 5. Domestic Fisheries Development

1. Rehabilitation and improvements to the Agat Small Boat Marina
2. Feasibility, design and permit, and construction for an alternative boat ramp location on Guam's eastern shores for accessibility of fishermen.
3. Purchase of a Fish Aggregate Device (FAD) deployment vessel to reduce the high costs of FAD deployments.
4. Design and construction for ADA compliant fishing/viewing platform at the Paseo de Susana Park along the Hagatna Marina Channel.
5. Development and promotion of Juvenile Rabbit Fish reproduction and restocking.
6. Capital financing for a new Guam Fishermen's Cooperative Marina Building Complex.
7. Supplement funding under the Dingell-Johnson Sports Fish Restoration Fund for the deployment and replacement of Fish Aggregating Devices (FADs) and Shallow Water Mooring Buoys (SWMs).

Objective 6. Recognizing the importance of island cultures and traditional fishing practices and community based management

1. Develop and promote education workshops and awareness campaign on Chamorro Traditional Fishing techniques.
2. Identification of traditional fishing methods; inventory of technical terminology accompanying indigenous fishing practices; and dissemination and translation.
3. Statistical analysis of traditional fishing practices and implementation of Master of Traditional Fishermen Program.

2.3 Project Selection and Evaluation

Guam's initial MCP objectives were prepared by the Council's PIAFA Working Group and were reviewed during three meetings held in Guam and Hawaii between 1996 and 1999. These meetings were attended by interested parties from various Guam public sector agencies, the U.S. government (Council, NOAA, NMFS, USCG) and the private sector. Following these meetings, an array of programmatic activities and projects were developed. Every three years since the development of Guam's initial MCP, Guam's MCP objectives, projects and programs have been assessed and updated to reflect changes. The objectives and specific strategies identified in the

MCP are consistent with the MSA National Standards, Operational Guidelines and applicable FEPs, as well as Government of Guam marine resource regulations.

2.4 Plan Review Process

Responsible entities are provisionally identified as being accountable for implementation of projects and for providing assistance where necessary to ensure that project aims are met.

Guam's MCP is not subject to Guam's Comprehensive Development Plan review process relative to Guam Code Annotated (GCA) 1205. The inclusion of the MCP as an element in the island's Comprehensive Development Plan would commit the Government of Guam to actions beyond a three year time frame with secure funding to carryout out the strategies identified in the MCP. The past decade has proven that PIAFA funds and fishing violation fees placed in the Western Pacific Sustainable Fisheries Fund are not a viable funding source since the quantity and timing of funds available for implementation of the MCP is uncertain. Those strategies that were identified in Guam's previous Marine Conservation Plans that have been carried out through other federal funding sources would be removed from this updated MCP once fully completed.

As a three year plan that is subject to change, Guam's MCP for 2017-2020 was made available for public review and comment through the Guam Fisherman's Cooperative Association, the Guam Association of Saltwater Anglers, the Marianas Underwater Fishing Federation, and to public sector marine related entities for their review and comment as well.

2.5 Prioritization of Objectives and Projects

The various projects described in the MCP are ranked high, medium or low priority. Activities designated as "high" are those deemed in need of immediate attention or resources. These rankings are subject to re-examination as conditions change. Ranked from highest to lowest priority, these projects are identified in the follow table:

No.	Project Description	Project Strategy No.	Amount	Priority
1	Capital Financing for A New Guam Fishermen's Cooperative Marina Building Complex: Phase III – Second Story to include Restaurant, Office Space, Meeting Lanai, Fisheries Museum, Conference/Classroom	5.6	\$3,500,000	High
2	Rehabilitation and Improvements to the Agat Small Boat Marina Dock B	5.1	\$1,000,000	High
3	Rehabilitation and Improvements to the Agat Small Boat Marina Dock B: A&E Design and Structural Assessment for Repair and Replacement of Refueling Pier, Boat Ramp and Boarding Pier	5.1	\$200,000	High
4	Rehabilitation and Improvements to the Agat Small Boat Marina Dock B:	5.1	\$1,500,000	High

No.	Project Description	Project Strategy No.	Amount	Priority
	Repair and Construction of Refueling Pier, Boat Ramp and Boarding Piers			
5	Accessibility for Fishermen – Eastern and or Northern Boat Ramp Feasibility Study to Identify a Location in to implement a Boat Ramp	5.2	\$50,000	High
6	Accessibility for Fishermen – Eastern and or Northern Boat Ramp: Design and Permit of the Boat Ramp	5.2	\$200,000	High
7	Accessibility for Fishermen – Eastern and or Northern Boat Ramp: Construction of Boat Ramp	5.2	\$700,000	High
8	Fish Aggregating Device Deployment Vessel	5.3	\$250,000	High
9	Chamorro Traditional Fishing	6.1	\$60,000	High
10	Guam Volunteer Fishery Data Collection Project	1.3	\$50,000 GFCA	High
11	Abandoned Gill Net Removal from Reefs	1.1	\$15,000	High
12	Improving Relationships between Resource Managers, Local and Migrant Fisherman	6.1 & 6.2	\$19,000	High
13	Shallow Bottom Fishing along the Outer Reef Flat: The Effects of Long Term Unsustainable Fishing Effort, Marine Preserve Designation, and Effort Limited by Rout Sea Conditions	1.3	\$29,000	High
14	Longline Permit, Reporting, and Quota Utilization Program to Facilitate Responsible Fisheries Development	3.1	\$100,000	Medium
15	Habitat Assessment and Monitoring	1.1	\$50,000	Medium
16	Near-shore Data Collecting	1.2	\$80,000	Medium
17	Fish Aggregating Devices and Shallow Water Mooring Buoys	5.7	\$100,000	Medium
18	Marine Conservation Public Education Campaign	4.1	\$5,000	Medium
20	Assessing the Health of Giant Clams (Tridacna) Populations	1.1	\$144,310	Medium
21	Environmental DNA Metabarcoding of Reef Fish Communities	1.1 & 1.3	\$85,000	Medium
22	Health Management of Manahak (Rabbitfish) in the Hatchery for Restocking Purposes	5.5	\$148,000	Medium
23	Observer Program	2.1	Shared/\$100,000	Low
24	EEZ Enforcement	2.2	\$100,000	Low
25	Discovering the Cultural Importance of Fishing Techniques Through Associated Indigenous Linguistic Practices	6.2	\$35,000 per 12 month period	Low
26	Preservation of Traditional In-shore Fishing Practices	6.3	\$10,000 Phase I \$50,000 Phase II annually	Low

No.	Project Description	Project Strategy No.	Amount	Priority
27	Assessing population health of the Trumpet Snail (Charonia tritonis)	1.1	\$155,200	Low
28	Education Component in the School for a Marine Fisheries Program	4 & 6	\$100,000	Low

2.6 Completion and Update of 2011 & 2014 Marine Conservation Plan Projects

The Agat Small Boat Marina rehabilitation and improvements to Dock A, the Manahak Hatchery and Restocking, and the Americans with Disabilities Act (ADA) Accessible Fishing Platform Phases I and II are projects approved for funding under the 2011 Marine Conservation Plan that have been completed. The Capital Financing for a New Guam Fishermen's Cooperative Marina Building Complex was also identified as an approved project in the 2011 Marine Conservation Plan, however, no funding under the MCP was identified. Through the Guam Hotel Occupancy Tax, the financing for Phase I and Phase II was identified and the ground breaking for Phase I took place on January 21, 2017. However, Phase III will continue to be identified as a priority in the 2017 MCP. The following table provides information on the project approved for funding under the 2011 Marine Conservation Plan.

Program Strategy No.	Project Description	Status	Amount	Priority
5.1	Rehabilitation and Improvements to the Agat Small Boat Marina: Dock A	Completed	\$300,000	High
5.5	Manahak (Rabbit Fish) Hatchery and Restocking	Completed	\$150,000	High
5.4	The Americans With Disabilities Act (ADA) Accessible Fishing Platform <ul style="list-style-type: none"> Phase I: Construction Phase II: Expansion of 200 feet Phase III: Expansion of Fishing Platform by 45 feet 	Completed Completed On-going	\$330,000 \$250,000	High High
5.6	Capital Financing for A New Guam Fishermen's Cooperative Marina Building Complex <ul style="list-style-type: none"> Phase I: Construct 240 foot seawall the length of building to Pillhouse Bunker Phase II: First floor of planned 2-Story Facility to include Co-op Fish Market, Coffee Shop and Dive/Gift Shop Phase III – Second Story to include Restaurant, Office Space, Meeting Lanai, Fisheries Museum, Conference/Classroom 	Will commence soon Will commence soon Funding to be identified	\$3,500,000 Guam Hotel Occupancy Tax \$3,500,000	High High

The Agat Small Boat Marina was built by the Army Corps of Engineers and completed in 1989. It is located in the beautiful and peaceful southern village of Agat. By design, it was built to accommodate 163 vessels with shore side facilities for fuel, loading, car and trailer parking. Since its completion, there has been no major infusion of capital for improvements at the Agat Marina, primarily due to insufficient funding levels from marina revenues to sustain its operations. The continued lack of suitable infrastructure and equipment has long been identified as the major obstacles to the successful growth of Guam's commercial, recreational and charter fishing operations. Funding from the MCP allowed for the repairs and replacement of existing slips at the southern portion of Dock A with larger boat slips and floats that can accommodate larger and heavier boats. Pictures of the before and after repairs to Dock A are shown below.



The Manahak (Rabbit Fish) Hatchery and Restocking project was a collaborative effort between the 4-H Youth Development Program, Guam Cooperative Extension Service, the Guam Fisherman's Cooperative Association and the University of Guam's College of Natural Sciences to develop and promote a juvenile rabbit fish reproduction project. An artificial habitat for the juvenile rabbit fish was created in order to enable the fish to be used for restocking purposes. The juvenile rabbit fish were nurtured in artificial habitats for 6 months before restocking took place. Funding allowed this collaborative partnership and helped develop an enhanced systematic approach in informing and educating the community on the concept of restocking. As the project has been completed, in-kind services for the upkeep of the hatchery are being provided by the 4-H Program, University of Guam Cooperative Extension Service. Pictures of the hatchery and restocking project are shown below.



Harvesting the Manahak at East Hagatna



Restocking the Tank – day of harvest



Catching the stocks for release



Tagged and ready for release



Releasing the stocks

The Americans with Disabilities Act (ADA) is a comprehensive civil rights law that prohibits discrimination on the basis of disability. The ADA requires that newly constructed and altered state and local government facilities, places of public accommodation, and commercial facilities are readily accessible and usable by individuals with disabilities. Recreational facilities, including fishing piers and platforms, are among the facilities required to comply with the ADA access requirements. Paseo de Susana Park is an established popular recreational area owned and operated by the Government of Guam, however, no ADA access existed to water resources at parks along the Hagatna Marina Channel. The ADA Accessible Fishing Platform proposed to construct an access ramp and fishing platform that fully complies with ADA standards in order to provide recreational and subsistence fishing access to the Hagatna Marina Channel to Guam's disabled citizens. The proposed facility will consist of concrete surfaced ramps and platforms with steel guardrails and wheel stops approximately 15 feet wide and 75 feet for the second Phase of the project.

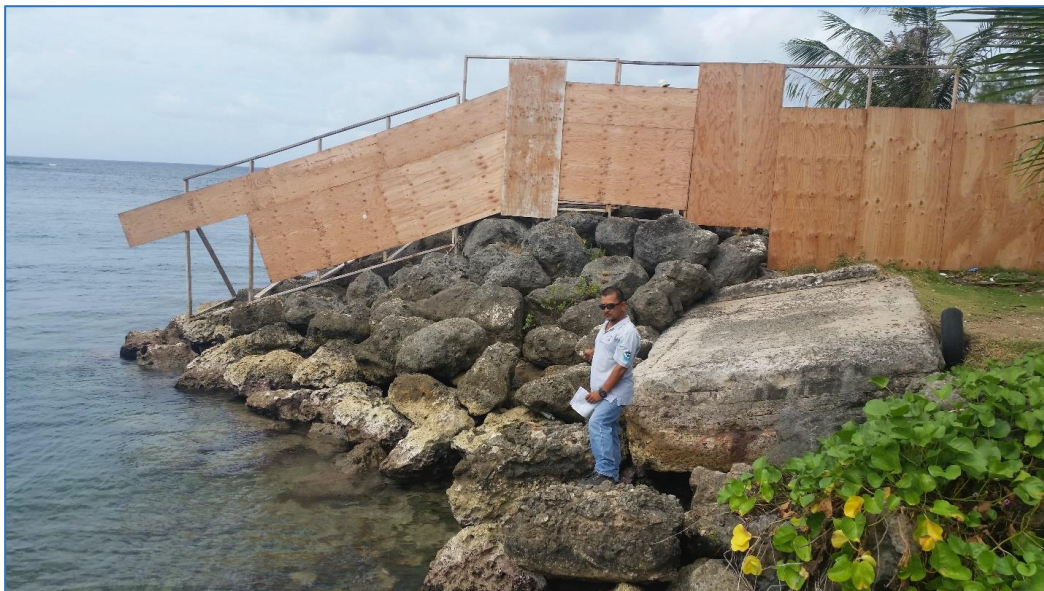
Following the completion of the A&E phase, the ADA Accessible Fishing Platform project was divided into three phases, and Phase I and Phase II have been completed. Phase I, was the construction of the ADA fishing platform at Paseo de Susana Park along the Hagatna Marina Channel and Phase II was the expansion of an additional two hundred feet to the Fishing Platform. Phase III of the ADA Fishing Platform originally called to add another two hundred and fifty feet to the platform in order to maximize the use of the accessible area. However, adjustments to this phase were made and the expansion will only add forty-five feet to the platform. Funding to complete Phase III will be made possible through the sale of transshipment quota. The following are pictures of the ADA Fishing Platform.



Phase I: Constructed ADA Fishing Platform



Phase II: ADA Fishing Platform extended 200 ft.



Phase III: ADA Fishing Platform (On-going) - Additional extension by 45 ft.

3. PROGRAM OBJECTIVES AND PROJECTS

The plan lists six objectives covering a diverse range of fishery conservation and management issues and initiatives. For each objective, strategies that are designed to specifically meet the objective are identified. The strategies' outline describes their purpose and scope, provide time frames and estimated funding required for their implementation and the evaluation criteria.

OBJECTIVE 1: Fisheries Resource Assessment, Research and Monitoring

General Strategy: To help meet this objective, cooperative research projects and joint project agreements with institutions, agencies, researchers and the fishing community to collect scientific fishery information, monitor fishery resources, assess research and monitoring programs, and support fisheries research will be conducted.

Project Strategy 1.1 Abandoned Gill Net Removal from Reefs

Need:	Abandoned gill nets are a hazard to both marine life and humans on the reef flats around Guam. Fish, crustaceans, and other gill breathing animals can get entangled and die, and air breathing animals such as endangered sea turtles can drown if unable to reach the water surface due to entanglement in a gill net. Abandoned gill nets can also entangle and break corals. With the recent listing of several coral species found on reef flats around Guam as endangered, there is a risk of impacting ESA species with abandoned nets. Abandoned nets are also a risk to recreational users and fishers. Gill nets can entangle arms and legs of unaware people in the water. They can snag hook and line fishing gear, causing loss of tackle, and increasing the hazards in the water. Twice abandoned gill nets have been found with highly venomous stonefish tangled in them. Stonefish can easily be overlooked when handling a gill net, and inflict an extremely painful sting.
Status Update:	Current Guam law has several statutes pertaining to gill net use, regarding size of net, size of mesh, and amount of time a net can be deployed before being removed. Despite these regulations, abandoned gill nets continue to be a problem on the reef flats around Guam.
Description:	Abandoned gill nets will be recovered wherever they are found on the reef flats around Guam. The location will be documented, Characteristics of the net will be logged, such as length, mesh size, estimated duration of abandonment, etc. Organisms entangled in the net will also be noted, with identification to lowest possible taxa, size, state (live, injured, or dead) and disposition. As fishermen are frequently the source of information for location of abandoned gill nets, an incentive program would be initiated to

reward fishers or other users for reporting gill nets. These incentives might include things such as fishing gear, hats, clothing, or gas cards. Abandoned gill nets will be retrieved and brought to the DAWR offices for cataloging and disposal

Priority Sequence:

- Small hand tools, e.g. knives, gloves and shears to be purchased to assist with removal of entangled gill nets
- Standardized data sheets will be created to document each gill net incident
- Purchase of incentive items for reporting public
- Establish an account to allow DAWR staff to bill work hours to gill net retrieval.

Priority Level: High

Time Table: 24 months

Cost Estimate: \$2000.00 for small tools and safety gear
 \$2000.00 for incentives for the public who report abandoned gill nets.
 \$15,000.00 for salaries of DAWR staff to recover and document abandoned gill nets

Accountability: Guam Department of Agriculture

Evaluation Criteria: An annual report will be generated, to include number of nets retrieved, number of incentives presented, length, size mesh of recovered nets, and status and disposition of all organisms entangled in abandoned gill nets

Project Strategy 1.1 Habitat Assessment and Monitoring

Description: The 2005 MCP states: *“There is an urgent need for long-term monitoring of sites as part of an integrated research program to provide the data necessary to show how Guam's reef systems are changing; to identify sources of stress in disturbed reef area; and to provide for proper coral reef management”*. Guam’s Coral Reef Initiative established a Long-Term Monitoring program in 2008, to address this concern. An additional project was initiated in 2009 to examine risks to coral health from sewage nutrient enrichment and was carried out by Raymundo and Kim, through the University of Guam Marine Lab. This study established seven permanent reef flat sites along the western coast of Guam which have been monitored since 2009 for coral community structure and coral health and disease. In addition, water temperature (using submersible HOBO® data loggers) and sewage-based nitrogen ($\delta^{15}\text{N}$ stable isotope analysis) have

been monitored. Long-term data sets such as these are rare, primarily due to funding restrictions, yet the quality of information that can be obtained from them is critical to informing management, examining questions of reef resilience, and predicting potential responses of coral communities to disturbance.

The long-term habitat assessment and monitoring of Guam coral reef flat communities will continue work which was started in 2009, to monitor coral health in connection with land-based sewage inputs. At present, six sites are monitored quarterly: Haputo, Tanguisson, Tumon, West Agana, Piti and Luminao. The project has since expanded to include coral community ecology monitoring, which includes assessment of coral recruit abundance, population size distribution, community structure, coral disease, bleaching, and predator outbreaks. Water temperature and nutrient inputs are also monitored simultaneously. If funds are made available for continuation of this monitoring, additional sites are planned, namely, the Achang Marine Preserve and Cetti Bay. Therefore, 3 out of Guam's 5 Marine Preserves will be regularly monitored (Tumon, Piti and Achang); these are the 3 most accessible sites with significant coral reef flat communities. Secure funding will also allow assessment and regular monitoring of the fish communities associated with these three reef flat sites which will serve to evaluate the continued performance of the Marine Preserves with respect to abundance of target species and health of fish habitat, and to assess community change in response to climate change and the military build-up.

Priority Level:	Medium
Time Table:	Monitoring currently occurs quarterly, and should continue for as long as funding allows. Data analysis is ongoing, and technical reports are prepared annually.
Cost Estimate:	\$50,000. The NOAA-CRCP program funds approximately \$30,000 per year, but this is inadequate to cover isotope analysis, purchase of field supplies, boat time, and part-time student assistance in the field. Additional PIAFA funding support is required.
Accountability:	The University of Guam Marine Laboratory
Evaluation Criteria:	Technical reports annually prepared for local and federal management agencies (BSP, GEPA, DAWR, NPS, USFWS, NMFS, and Council) would be critically reviewed by local managers and would be assessed based on the relevance of the results.

Project Strategy 1.1 Assessing the Health of Giant Clams (*Tridacna*) Populations

Background:

Giant clams, with their large size, characteristic shell structures and colorful mantles, are charismatic organisms that play important ecological roles in tropical marine environments (Mingoa-Licuanan and Gomez, 2002). Like hermatypic corals, each species hosts symbiotic photosynthetic zooxanthellae algae in their mantles, making them most often found in the clear shallow coastal waters accessible to humans. As a result, giant clams have tremendous cultural importance in Micronesia as a local food source and raw material for artisans, in addition to their long-recognized global value in cuisine and as attractive aquarium animals (bin Othman et al., 2010). Noticeably, *Tridacna* reproduction is dependent on adult density and past research has shown that populations become unsustainable when densities decline below certain levels (Apte et al., 2010). Yet, according to the World Conservation Union's Red List of Threatened Species (<http://www.iucnredlist.org>) seven species of giant clams are listed as either "Lower Risk Conservation Dependent" or "Vulnerable," including the three species found on Guam, due to their over-exploitation. The quest to become sustainable urges Guam to develop a local understanding of the diversity, status and health of giant clam populations in our region. Currently, there are 10 recognized species within the genus *Tridacna*, of which 3 are commonly found on Guam: *Tridacna maxima*, *T. derasa* and *T. squamosa* (Paulay, 2003). However, recent unpublished data suggests that giant clams could be much more genetically diverse, and multiple cryptic species most likely exist. In essence, we know little to nothing about the population structure and stock size of wild giant clam populations on Guam.

To address these knowledge gaps, we propose to conduct a two-pronged assessment of the wild stocks of giant clams on Guam. Classic field observation techniques will be employed to determine morphological and spatial distributions of populations around the island, and a state-of-the-art population genomics assessment of local populations will be used to define their effective population sizes, population structure and genetic connectivity. Through this mélange of classic and cutting edge techniques, we will increase our local capacity for managing this iconic coral reef species, our knowledge of how to do so effectively, and the ability of the local people to depend on this culturally important resource for generations to come.

Description:

The two overarching objectives of our work are: i) to determine the number of *Tridacna* species present on Guam; and ii) to evaluate the current state of these wild populations in terms of both population and

genetic structure. If awarded funding, a UOGML Master of Science Student will be conducting this research as her thesis topic under the co-supervision of Professors Biggs (co-PI) and Lemer (PI). Appropriate funding support for their respective effort commitments is requested.

UOGML-based field monitoring techniques will allow us to photo-document, GIS map, and morphometrically-assess giant clam population densities, distributions and demographics throughout our study area. In year 1, multiple sites around Guam will be surveyed and sampled by our scientific divers. During the surveys, quantitative data will be collected such as population size (i.e. number of specimens found at one site), geo-localization of *Tridacna* occurrences, specimen size and photo ID. In addition, non-lethal tissue samples will be collected from all specimens for subsequent population genetics. Funding is requested to support the use of UOGML vessels, an underwater camera with a quadrat frame, one GPS unit, and supplies for measuring, sampling, and taking notes. In year 2, the collected data will be analyzed and the potential benefit of expanding the study area to nearby islands (Saipan, Tinian, and Rota) will be evaluated.

Molecular data will be generated in-house, by our Next-Seq500 (Illumina, Inc.) genome sequencer using Restriction-site Associated DNA-Sequencing (RAD-Seq) methods. In year 1, each surveyed specimen will be genotyped and the resulting sequences will be archived within the UOGML Biorepository. Later these will be made available via the Guam Ecosystems Collaboration web-server. Our RAD-Seq technique generates around 10,000 to 20,000 SNPs per specimen, which provides the genetic information for multiple avenues of post-hoc analyses beyond the scope of our original study, so availability to the scientific community for future work is paramount. With this in mind, it is important to note that all of the equipment necessary to create genomic data directly from the field in less than 72 hours (sequencer time inclusive), are already functional within our NSF-funded, marine genetics laboratory: multiple tissue homogenizers; automated DNA extraction, and a NeoPrep™ sequencing-ready library construction robot are included within our NextSeq500 sequencing pipeline. Funding is requested only for the consumable supplies and reagents needed to run this equipment, a project-specific long-term data storage device and its associated cloud back-up, and a laptop computer for the student to conduct data analyses within our network. Effort of associated personnel has already been considered.

In year 2, we will conduct a series of population genetic analyses on the *Tridacna* data generated during year1 by this pipeline. Our analyses will help answer the following questions:

How many species of giant clams exist in our area? *Biodiversity*

1. How can we tell those species apart from one another? *Taxonom*
2. How genetically diverse are these populations? *An important indicator of population past and present demographic history*
3. What are their effective population sizes? *Informs on the actual number of genitors necessary to maintain a stable population.*
4. How connected are these populations? *Informs on the reproduction and dispersal capacities of Tridacna and their recovery capacities.*

Our analyses will also help us identify source and sink populations, and the relative effectiveness of our management areas. Together, these techniques will provide an in-depth understanding of the current state of giant clam populations on Guam.

Priority ranking: Medium

Time table: 24 months

Cost estimate: \$144,310

Direct Costs for this 24-month project are \$101,114. This includes a one-time supply purchase and shipping totaling \$20,000 of consumable supplies and reagents associated with our field surveys, diving, sample collection, DNA extraction, RAD-Seq library preparation, sequencing, genotyping, and data archival of 200-400 specimens of *Tridacna*. The remainder will fund the PI (\$15,000), Co-PI (\$8,000), and graduate student salary for two years (\$50,214), 20-days of UOGML vessel, fuel, and operator fees (\$260/day * 20 = \$5,200), a lap-top computer (\$1,200), and modest anticipated publication costs (\$1,500).

Indirect Costs Federal negotiated indirect cost rate for the University of Guam is 59% of salaries for personnel affiliated with the project, and amounts to \$43,196 ($\$73,214 \times 0.59 = \$43,196$).

Accountability: The University of Guam Marine Lab and the Research Corporation of the University of Guam will provide the administrative support for this project. The PI and Co-PI will direct and oversee project timelines, milestones, and outcomes. The Graduate Research Assistant will conduct day-to-day activities and aid in the data analyses, dissemination, and outreach.

Evaluation criteria: Technical reports annually prepared for local and federal management agencies and peer-reviewed publications. Year 1: Annual report of

specimen data collected, including population densities, distribution areas and individual size ranges; presentation of preliminary genetic data (i.e. assessment of species diversity). Year 2: Complete write-up of results on population health of *Tridacna* based on the combination of genetic and field monitoring data. Scenarios for informing management decisions of federal and local management agencies will be presented.

Project Strategy 1.1 Assessing Population Health of the Trumpet Snail (*Charonia Tritonis*)

Background: Trumpet snails, are charismatic organisms that play an important ecological role in tropical marine environments. They have great cultural importance in Micronesia as a local food source and craft, as demonstrated by their selection as the mascot for the University of Guam. In addition, trumpet snails also have an important commercial value on the seashell market due to their large, emblematic shells. Since thousands of years trumpet snails have been collected by Pacific Islanders for food and ornamentation (Kay, 1995). Yet, they occur naturally at low densities across the tropical Indo-Pacific and have become rare in most inhabited Pacific islands including Guam, because of increased over-fishing and pollution (Hedlund, 1977). Population densities have become so low that trumpet snails are now protected by law in many countries, including Australia, French Polynesia and the Seychelles.

Low population sizes are concerning because, among other things, *Charonia tritonis* is one of the few predators of large sea stars like the coral-killing crown-of-thorns, *Acanthaster planci* (Birkeland and Lucas, 1990). Periodic outbreaks of *A. planci* are intense disturbances that can decimate coral reefs (Kayal et al., 2012) and eliminate up to 6 km² of living coral tissue in a single year with dramatic consequences such as: alteration of coral community structure, promoting algal colonization, and affecting fish population dynamics (NOAA). Decreases in trumpet snail population sizes due to overfishing leads to reduced predation on *A. planci* and thus contributes to sea star outbreaks (Birkeland and Lucas, 1990).

Despite their cultural and ecological importance we know little to nothing about population structures and population sizes of this emblematic gastropod on Guam. In the context of its recent global and regional decline it is of paramount importance to rapidly develop an understanding of the status and health of trumpet snail populations in our region. To address these knowledge gaps, we propose to conduct a two-sided assessment of the wild stocks of trumpet snails on Guam. Classic field observation techniques will be employed to determine morphological and spatial distributions of populations around the island, and a state-of-the-art population genomic assessment of local populations will be used to define

their effective population sizes, population structure and genetic connectivity. Through this combination of classic field-based and cutting edge genetic techniques, we will increase the local capacity to manage and preserve this iconic coral reef species for generations to come.

Description: The two main objectives of our work are: a) to evaluate the abundance of *Charonia tritonis* on Guam; and b) to determine their genetic structure. The proposed research will be conducted by a UOG Marine Biology Master of Science Student as their master thesis under the co-supervision of Professors Lemer (PI) and Combosch (co-PI).

Field observation: UOGML-based field monitoring will allow us to evaluate population densities, distribution areas and demographics throughout our study area. We will use underwater photography, GIS mapping, and morphometrics. During year 1, 10 sites around Guam will be surveyed for the presence and abundance of trumpet snails. *Charonia tritonis* preferred habitats are shallow coral reefs and sand patches around coral bummies between 5 and 20 meters deep, which are easily accessible by scuba diving. Funding is requested to support the use of UOGML vessels, dive gear for the graduate student, an underwater camera with a quadrat frame, one GPS unit, and supplies for measuring, sampling, and note taking. In year 2, the collected data will be analyzed and be made available on the UOGML Biorepository via the Guam Ecosystems Collaboration web-server.

In addition to quantitative abundance and demographic data, non-lethal tissue samples for subsequent population genetics will also be collected during field surveys. A small piece of foot or mantle tissue will be extracted, either directly underwater or after relaxing the specimen in diluted magnesium solution (to prevent retraction into the shell).

Population genetics: All molecular work will be conducted in the Marine Laboratory at the University of Guam. Population genomic data will be generated using a Restriction-site Associated DNA-Sequencing (RAD-Seq) method. During year 1, DNA will be extracted from surveyed specimens and RAD-Seq DNA libraries will be prepared. All individuals will be genotyped and the resulting sequences will be archived in connection with the field picture and morphometric data in the UOGML Biorepository and made publicly available via the Guam Ecosystems Collaboration web-server. Our RAD-Seq technique will generate over 10,000 independent SNPs per specimen, providing ample data at moderate cost. Importantly, all equipment necessary to create genomic RAD-Seq data is already available at the University of Guam Marine Laboratory:

multiple tissue homogenizers, automated DNA extraction robots, a NeoPrep™ sequencing-ready library construction robot and the NextSeq500 sequencing machine. Funding is requested only for the consumable supplies and reagents to run the equipment. Effort of associated personnel has already been considered.

Year 2 will be dedicated to the analyses of the population genomic data generated during year 1. The main focus of our analyses will be the following questions:

1. How genetically diverse are trumpet snail populations? *An important indicator of population past and present demographic history.*
2. What are their effective population sizes? *Informs on the actual number of genitors necessary to maintain a stable population.*
3. How connected are these populations? *Informs on the reproductive and dispersal capacities of trumpet snails and their recovery capacities.*

Our analyses will also help us to identify source and sink populations, and the relative effectiveness of our management areas. Together, these analyses will provide an in-depth understanding of the current state of trumpet snail populations on Guam and help define both management and conservation policies to preserve trumpet snail populations.

Priority ranking: Low

Time table: 24 months

Cost estimates: \$155,200

Direct Costs for this 24-month project is \$108,000.

This includes \$20,000 of consumable supplies and reagents associated with our field surveys (including dive gear, underwater camera incl. photo quadrat, 20-days of UOGML boat, fuel and operation fees) and laboratory work (DNA extraction, RAD-Seq library preparation, sequencing, data analyses and archival for ~200 specimens of *Charonia tritonis*).

The remainder will fund the PI (\$18,500), Co-PI (\$14,500), and graduate student salary for two years (\$55,000).

Indirect Costs: Federal negotiated indirect cost rate for the University of Guam is 59% of salaries for personnel affiliated with the project, and amounts to \$47,200.

- Accountability: The University of Guam Marine Laboratory and the Research Corporation of the University of Guam will provide the administrative support for this project. The PI and Co-PI will direct and oversee project timelines, milestones, and outcomes.
- Evaluation criteria: Technical reports annually prepared for local and federal management agencies and peer-reviewed publications. Year 1: Annual report of specimen collected including population densities, distribution areas and individual size ranges; presentation of preliminary genetic data. Year 2: Complete write-up of results on population health of *C. tritonis* based on the combination of genetic and field monitoring data. Scenarios for informing management decisions of federal and local management agencies will be presented.

Project Strategy 1.1 & 1.3 Environmental DNA Metabarcoding of Reef Fish Communities

Background: In recent years, high-throughput DNA sequencing (i.e., metabarcoding), has been widely presented as a promising tool to survey entire communities of prokaryotic and eukaryotic organisms (Bik et al. 2012; Cristescu 2014; Kense & Schils 2017). Such metabarcoding surveys are rapidly complementing or replacing traditional field surveys because of their precise taxonomic accuracy, high detection capability, cost-effectiveness, and the possibility for rapidly screening large numbers of samples (Corlett 2017). Technological advances have opened new possibilities for species detection and identification using DNA present in the environment (environmental DNA or eDNA; Taberlet et al. 2012). This approach is particularly useful to detect the presence of organisms in aquatic environments, including rare or difficult-to-sample taxa (Ficetola et al. 2008; Takahara et al. 2013) such as larger food fishes on Guam forereefs. Traditional fish community assessments suffer from (1) the temporal unpredictability of transient fishes, especially larger food fish, (2) the difficulty of detecting species in cryptic habitats, (3) a significant degree of observer bias, and (4) the diurnal variation of fish assemblages. Reliable estimates of fish community composition and the occurrence of larger food fishes require a high number of replicate surveys, preferably conducted at different times in the day and in different seasons. All these aspects create uncertainty when analyzing data and render comparisons between surveys campaigns difficult.

Accurate richness and diversity assessments of fish communities are, however, essential to evaluate coral reef health and fishery stocks. Guam is the largest and most densely populated island in the Mariana Islands and its longstanding history of intense fishing pressure is reflected in low reef

fish biomass compared to most other Pacific Islands (MacNeil et al. 2015). As a result, the distribution of fish biomass around Guam is strongly correlated with the protection and conservation status of reef habitats (Williams et al. 2012). Strong fishing pressure has altered fish behavior significantly as fish have become more elusive and are thus more difficult to observe in the field, which results in biased inventories of fish community composition. Studies in Guam have indeed shown such a refuge effect, where fish hide out in deeper parts of the reef (Lindfield et al. 2014a) and are alarmed by sounds linked to human presence (Lindfield et al. 2014b).

Optimizing eDNA metabarcoding of Guam's reef fishes will establish reliable and consistent monitoring of fish diversity, including the quantification of larger target species once calibrated. These outcomes offer immediate, positive benefits for coral reef conservation and fishery management.

Description:

The first year of the project will focus on the qualitative detection of fish species at the permanent monitoring sites of the Guam Long Term Coral Reef Monitoring and the CESU Marine Monitoring Programs. First, a replicated sampling protocol will be designed and tested to accurately represent monitoring sites. The collected seawater samples will be filtered, preserved in DNA conservation/lysis buffer, eDNA will be extracted, purified and amplified, and sequenced on an Illumina MiSeq next-generation sequencer following library preparation. Next, bioinformatics will be used to cluster and match the millions of sequence reads with fish taxonomy at the species level.

Research questions in this first phase of the project will focus on the detection of fish species important for marine conservation planning:

- Overall reef fish diversity measures obtained from the eDNA metabarcoding study will be correlated with diversity assessments based on traditional survey techniques for the permanent marine monitoring sites in Guam.
- The bumphead parrotfish (*Bolbometopon muricatum*; atuhong) has been heavily targeted by spearfishing in Guam. A screening of the occurrence of this ecosystem engineer in 23,001 fish records from surveys in Guam revealed zero occurrences. Meanwhile, catch records collected during interviews with fishermen between 1985 and 2016 have reported nine individuals in the 1980's, one in 2001, and none thereafter. As such, this fish appears to be driven to near-extinction in Guam, which reflects the overall sharp decline of this species in the Indo-Pacific region (Chan *et al.* 2012). Biologists and recreational

divers, however, still observe *B. muricatum* individuals occasionally, which might indicate that the species has become weary of humans and has retreated to deeper waters or remote reef locations around the island. Environmental DNA metabarcoding will allow for the detection of locations where bumphead parrotfish populations still exist and may help to identify high priority sites for the conservation of bumphead parrotfishes in Guam.

- The humphead wrasse (*Cheilinus undulatus*; tanguisson) is another reef giant that has traditionally been important in the Chamorro fishing culture. Individual numbers of this species have dwindled in recent years because of the adoption of more intense and modern fishing practices. This species makes up 0.2% of all fish survey records from Guam and in each of the recorded humphead wrasses belonged to smaller, juvenile size ranges. Catch records also show a consistent decline in the abundance of this species since the mid-1990's, but these trends are based upon limited data. eDNA metabarcoding surveys may detect humphead wrasse hotspots in Guam, which will aide marine conservation efforts to protect this species.
- Guam has adopted a shark-finning ban which has now reached the end of its first cycle as a law. To evaluate the effectiveness of this law, assessments of shark diversity around the island are required. Metabarcoding surveys focusing on sharks (dedicated primers) will allow for the identification of areas with healthy and diverse shark populations.
- The second year of the project will focus on a quantitative analysis of reef fish communities by calibrating read numbers with population estimates obtained from traditional survey techniques. Calibrations will be conducted in controlled systems like aquaria (e.g., UnderWater World Guam), mesocosms (e.g., raceways at the UOG hatchery), and well-characterized enclosed reef communities with a high fish diversity (e.g., Piti Fish Eye). Quantitative assessments of eDNA data could provide instant stock estimates for a wide-range of fish species. Such factual data will facilitate and steer interagency discussions on the implementation of traditional or new management practices to sustain healthy reef fish populations. Stakeholders and policy makers also need such high-resolution data to discuss, develop, and implement new, species-specific fishery regulations. Quantitative analyses of the metabarcoding results for the permanent monitoring sites will answer much needed management questions related to Guam's marine protected areas (MPAs). As such, the eDNA data will allow for a thorough investigation of MPA effectiveness and spill-over effects.

Priority Ranking: Medium

Time Table:	24 months
Cost Estimate:	\$85,000: \$45,000 in Year 1 \$40,000 in Year 2
Accountability:	University of Guam Marine Laboratory
Evaluation Criteria:	Project progress will be communicated through semi-annual reports to the Department of Agriculture and the Bureau of Statistics and Plans of the Government of Guam. Important milestones in technique development and data analysis will be illustrated with examples of their applied benefit to fisheries conservation. At the end of the two-year study, one or two manuscripts will be prepared in collaboration with representatives of natural resource agencies of the Government of Guam. These manuscripts are to be submitted to respected scientific journals in the fields of marine conservation and fisheries research. All data will be made available to the government and scientific community through open access digital repositories like Dryad (http://datadryad.org).

Project Strategy 1.2 Near-shore Data Collection

Need:	Basic life history information such as movement and growth and age on important reef fish species in order to support informed marine resource management of Guam's fisheries
Description:	<p>A community-based near shore reef fish tagging program utilizing local fishermen from the local community is required in order to release 2,000-tagged reef fish for one-year period throughout Guam's near shore areas. The Pacific Islands Fisheries Group intends to partner with Guam's local fishing community, non-profit community organizations, 4H school clubs, local businesses and fishery management authorities to foster public-private partnerships, community ownership, collection of basic scientific information and informed resource management.</p> <p>The University of Guam 4H Youth Development Program has been working with the Guam fishing community and state and federal fishery agencies to support the popular and successful White Snappers tagging and other species in the future. Results from the Snappers tagging project will provide the first comprehensive estimates of natural and fishing mortalities of key predator species in Guam's coastal zone. These data will be incorporated into stock assessment models for these species, which will provide a quantitative assessment of the impact of fishing in Guam's coastal zone. After the in shore tagging, this project will extend its outlet to deep bottom tagging.</p>

Short-term benefits from this project will include estimates of growth and movement of key reef fish species in Guam's coastal zone. These data will also be useful to better understand temporal movement patterns and growth rates under varied environmental conditions.

Long-term benefits of the project may include comprehensive estimates of natural and fishing mortalities for key reef fish species in Guam. Data collected through an island-wide tagging project can be incorporated into future stock assessments, which can lead to a quantitative assessment of the impact of fishing in Guam's coastal zone. The project will also provide valuable movement activity, which will support Guam's MPA monitoring program and whole island stock assessment.

Priority:	Medium
Time Table:	12 months
Cost Estimation:	\$80,000
Accountability:	University of Guam Youth Development Program- 4H
Evaluation Criteria:	Pre and Post evaluation will be an instrument to measure knowledge. Data sheet for number of participants, number of fish tagged and retrieved.

Project Strategy 1.3 Guam Volunteer Fishery Data Collection Project

Background:	Good fishery data by Guam's local fishing community, which includes its commercial, recreational and subsistence fishers, is needed to provide a history of catch, to help identify why changes are occurring in marine resources and to assess the status of the stocks. The data also will enable Guam to assess how its fisheries are changing over time and their dynamics. To help improve Guam's fish stock, seashore preserves have been established and other regulations are under consideration to promote the development and sustain ability of Guam's fishery. Through the use of fishery data, the impacts of current and proposed regulations upon the fisheries, fishermen and the fishing communities can be determined. Guam's fishermen and fishing industry will be able to work more effectively with government fishery managers to develop regulations and laws that address their needs and while protecting the fishery resource.
Description:	This project is in addition to the Creel Survey that is conducted by DAWR. Through this project, the Guam Fisherman Cooperative Association recruits fishermen to participate voluntarily in collecting data.

At a minimum, the local fishing community will annually fill out survey form. They will also be actively encouraged to fill out and return a Fishing Trip Survey form to document all fishing trips using any fishing method. Funding is required to develop and print voluntary catch logs that will be given to fishermen, to provide additional secure drop boxes in which fishermen can submit their catch logs, and to contract the services of an individual to enter the data from the catch logs into the data system.

Priority:	High
Time Table:	On-going
Cost Estimate:	\$50,000 for the Fishery Data Collection activities by GFCA.
Accountability:	Guam Fishermen's Cooperative Association.
Evaluation Criteria:	Annual report on the amount of fish harvested by Guam's subsistence and commercial fishermen and the economic impact the fish harvest has upon Guam's economy.

Project Strategy 1.3 Shallow Bottom Fishing along the Outer Reef Flat: The Effects of Long Term Unsustainable Fishing Effort, Stocked from Marine Preservation Designations and Protected by Rough Sea Conditions

Background: Hook-and-line fishing and bottom fishing can be considered the most popular recreational fishing methods on the island. Hook and line fishers make up 70% of shoreline fishing activity, making it the most popular shoreline fishing method. For boat-based fishers, bottom fishing is second only to trolling. This method generally captures shallow water species of snappers (*Lujanidae*), groupers (*Serranidae*), emperors (*Lethrinidae*), and trevally (*Carangidae*). However, important economic deep water snapper species, from the genera *Etelis* and *Pristipomoides*, are also caught. For trevally, hook-and-line fishing targets all life cycles stages beginning with juvenile, an important fishery when seasonal schools enter bays and feed along the shoreline, to mature adults of the giant trevally (*Caranx ignobilis*). This fishing method is done by recreational, subsistence, and commercial fishers.

Hook-and-line or bottom fishing is the most common fishing method for several reasons. First, this fishing method does not require expensive gear, such as nets, and proficiency can be taught to young children. Second, the method is relatively safe since the fisher does not need to enter the marine environment and increases their risk of drowning,

observed with spearing. Lastly, this method can be done as a solitary activity or with groups of friends or family. Hook and line fishing can be done in both fresh water and the marine environment, with fishing structures at Masso Reservoir, have been constructed to increase access to fishing areas and to make this fishery safer. Agriculture constructed Masso Reservoir, the Merizo Pier, and the platforms at Ylig Bay, Jeff's Pirate's Cove, and the Paseo. Hook and line fishing is the only method that can be done year round at two of the five marine preserves, the Tumon Bay marine preserve and the Pati Point marine preserve.

A significant factor that impacts bottom fishing and hook-and-line fishing is that other fishing methods also harvest snappers, emperors, groupers, and jacks. Gill nets and drag nets can easily deplete the same species when done unsustainably. Spear fishers impact bottom fish species in areas that are frequently fished by commercial SCUBA divers and commercial free divers. Lastly, harvest for recreational fishers can be impacted from commercial fishing activity, especially commercial boats that take numerous daily trips of large groups of fishers to the same stretch of shallow reef.

Fishing activity is concentrated on the west side of the island. Access to the east side is limited due to challenges with makeshift boat ramps and rough sea conditions during most of the year. Fishing on the east side, therefore, is limited to the calm summer months or short periods when sea conditions allow boaters to either launch off makeshift ramps or travel from public boat ramp at Agana or Merizo. During these calm periods, however, fishing effort can be high, especially if there are commercial fishers. Stretches of reefs on the east coast, too, are relatively small, making it easy to impact them in a short period. While rough sea conditions limit fishing effort, fishing activity during periods of calm seas may impact fish stocks if fishing activity is high. Historically, the east side has been fished extensively by commercial SCUBA fishers and gillnets, two methods which are capable of impacting fish stocks.

The Department of Agriculture's Fisheries section has been collecting data from shore based hook-and-line fishers and boat-based bottom fishers since the 1970s. This allows various fishing sectors to be analyzed for trends in catch, participation, and effort. At the Agat marina, commercial bottom fishers have been surveyed since the opening of the marina in the 1990s. During the early 1990's, as many as four (4) commercial operators began operating out of the Agat marina with as many as 30 guest bottom fishing along the same two mile stretch of reef at Agat. This provides a unique opportunity to analyze the effect of high fishing effort over a

relatively long period on a small reef areas. An initial analysis shows that catch trend of rapid depletion of important fish species, then a decrease in the size of fish harvested, then finally, catches comprise of juveniles and non-desired smaller fish species.

Public Law 24-21 was passed in 1997 that established five (5) permanent marine preserves. Two of the preserves, the Tumon Bay and Pati Point marine preserves, allow limited hook-and-line fishing year round. The Pati Point marine preserve allows shoreline hook-and-line fishing for all species, while the Tumon Bay marine preserve allows shoreline hook and line fishing for only rabbitfish, convict tang, and juvenile jacks. Boat-based bottom fishing is allowed to begin at the 100 foot contour at the Tumon Bay marine preserve, while is allowed only beyond the 600 foot contour at the Pati point marine preserve, Achang bay marine preserve, and the Piti bomb holes marine preserve. The Tumon bay 100-foot contour, however, is regularly fished by commercial bottom fishing charter boats from the Agana boat basin, proving an opportunity to observe the effect of having high fishing effort and the spillover effect simultaneously.

Description:

The objective of this project is to analyze the effect that high fishing effort has had on shallow reef fish stocks. This includes areas that limit fishing effort by legislation, marine preserve, and from rougher sea conditions, reef areas on the east side.

Data on bottom fishing activity from commercial boats from the Agat marina provide a unique opportunity to observe the effect of high fishing effort over a long period on small reef areas. This impact on the fish populations of the outer reefs at Agat from these boats can then be compared with reef fish stocks along the Tumon Bay marine preserve, from which some data is available, and reefs on the east side of the island. The CPUE, the predominant species caught before and after fishing effort increased, and general fish size can then be compared and discussed. The resultant data can answer questions relating to the effect of high fishing effort over time, marine preserve designation, and the effect of natural closure due to seasonal rough sea conditions. Management options currently in practice can then be discussed and analyzed for their effectiveness, and compared with areas having minimal regulations.

Agriculture's boat-based creel program have been collecting catch and effort data from commercial bottom fishers from the Agana boat basin and the Agat marina. This source of data will first be separated out and analyzed. Commercial bottom fishing operators from the Agat marina

were surveyed since the marina first opened in the 1990s when their activity first began. Commercial bottom fishing boaters from the Agana boat basin were less common but also collected, usually the commercial trolling boats also engaging in bottom fishing. Bottom fishing activity limited to the Agat reef flat and Tumon Bay can be separated out from the boat based creel system.

Second, the commercial fishing boats from the two public marinas will be approached for their assistance in allowing staff to observe their guests fishing. This will provide current data on effort, participation, and catch data from bottom fishing occurring along Agat and Tumon Bay. Fisheries staff have a generally good relationship with the commercial boat operators, although an incentive may be required for their assistance. This part of the project will be limited to staff observing and collecting catch data without interfering with the operation of the fishing charter.

Lastly, Fisheries staff will conduct limited fishing trips to Agat Bay, Tumon Bay, and weather permitting, the east side of the island to conduct shallow bottom fishing. These trips will provide catch and effort data to compare with the catch observed on the commercial fishing boats. Currently, the number of trips required to make the study valid has not been determined.

The resultant data will be analyzed in several ways. First, historical data from the Agat marina commercial bottom fishing boats that fished along the outer reef flat at Agat will be analyzed, to observe if any trends occurred over time, especially with catch composition and fish size. The dataset should provide a picture of the effect of constant fishing effort on a relatively small section of the reef. Second, commercial bottom fishing activity that occurred at Tumon bay will be analyzed, and to see if there has been any effect on catch composition due to the bay's designation as a marine preserve. Lastly, catch composition and fish size from fish caught on the east side of the island will be analyzed to observe any trends that result from the natural closure of the area from rough sea conditions.

Local fish resources are important, both economically and culturally. However, impacts to local fish stocks are numerous and complex. Analyzing and collecting data on bottom fishing activity, focusing on the effect of long term constant fishing effort, the effect of being designated a marine preserve, and the effect of rough seas naturally limiting fishing activity can be useful to determine the effectiveness of local regulations and local fishing practices. The results of this project may clarify whether

additional management options or different approaches should be considered to help increase fish stocks.

Management of the marine environment to ensure that fish stocks are healthy is complex. On the plus side, laws such as the marine preserve regulations limit fishing effort and provide “no-fishing” zones to allow individual fish to increase in size and fish numbers to increase. The increase in fish size allows fish to reach larger sizes, with these larger fish producing more eggs and healthier eggs. The increase in the number of fish in the preserves would allow fish to “spill over” to adjacent fishing areas. Educational outreach activities are an important part of fishery management. Fishers are encouraged to practice ethical and sustainable fishing practices and non-fishers are encouraged to practice good stewardship of the environment. Both are necessary to keep fish stocks healthy. On the other hand, impacts which decrease fish stocks include over fishing and degrading of the marine environment. Both can significantly decrease fish stocks. Environmental impacts that negatively impact fish stocks include marine activities such as dredging and damaging coral, but also land based activities that introduce soil, contaminants, and trash into the marine environment. Within the fishing community, impacts have also been divided separating commercial fishers, recreational fishers, and subsistence fishers. Fishing activity has also been divided along ethnic and resident lines.

Priority Ranking:	This project can be considered a ranking of High. It combines the analysis of boat-based fishery data and compares three (3) areas that have three different management strategies.
Time Table:	The project is expected to take one fiscal year.
Cost Estimate:	This project is estimated to cost \$29,255. Most of the cost would be for staff time, engaged in either the collection of fishing data or data analysis. A maximum of five (5) staff would be ideal for the project, and equipment for each would include fishing gear and protective gear. Other equipment and supplies needed for the project would include two coolers, three measuring boards, bait, fuel for the agency boat, and miscellaneous office supplies.
Accountability:	The Department of Agriculture’s Division of Aquatic and Wildlife Resources. The coordinator for this project, however, would be Fisheries Biologist Thomas Flores, Jr., responsible for the project tasks and progress reports.

Evaluation Criteria: Annual report describing the effect of long term fishing effort on a specific outer reef flat that has historically been utilized by commercial bottom fishers and where fishing data has been collected. This will be compared with two other outer reef flats having different management strategies: an outer reef flat that has a marine preserve designation and where data has been collected, and outer reef flats on the east side of the island that experiences natural rough seas. The effect on bottom fish species, fish size, and fish diversity will be analyzed and discussed.

OBJECTIVE 2: Effective Surveillance and Enforcement Mechanisms

General Strategy: Support activities designed to provide effective compliance with fisheries management measures, including the implementation of observer programs, inspection schemes, enforcement training, vessel monitoring systems and other technologies to monitor fisheries.

Project Strategy 2.1 Observer Program

Background: The MSA states that prior to entering into a PIAFA, the Governor, in consultation with the Council and NMFS, must establish an observer program that has been approved by the Secretary in consultation with the Western Pacific Regional Fishery Management Council and is at least equal in effectiveness to a program established by the Secretary. Therefore, a PIA fishery observer program must engage in the collection of comprehensive information on foreign fishing activities, including fishing location, catch and effort, by catch and protected species interaction. The level of coverage will need to be determined and may vary depending on the terms and conditions of the PIAFA, the types of foreign vessels engaged in fishing and the implementation of a VMS.

Description: Guam has the option of establishing its own observer program under a PIAFA. Presently, NMFS is providing observers and spends in excess of \$7,000 to \$10,000 per person-month for at-sea observers. Associated with these costs are additional various administrative costs such data key punching and port coordination.

Priority Level: Low

Cost estimate: It is assumed that the major costs of implementing an observer program will be borne by the foreign entity acquiring fishing access rights under a PIAFA. An additional \$100,000 is required for data entry and port coordination related activities that must be undertaken by the Government of Guam.

Accountability: NMFS, Western Pacific Regional Fishery Management Council and Bureau of Statistics and Plans

Project Strategy 2.2 EEZ Enforcement

Background: The Council's jurisdiction covers an area of nearly 1.5 million square miles (Figure 1). Enforcement capabilities at the federal level for the insular areas of American Samoa, Guam and the Northern Mariana Islands consist of NMFS enforcement agents and limited U.S. Coast Guard support. A federal-local cooperative agreement has been completed that permits Guam law enforcement and conservation officers to assist in the enforcement of the MSA, the Endangered Species Act and the Marine Mammal Protection Act.

Description: Additional enforcement services are required to enforce the MSA, the Endangered Species Act and the Marine Mammal Protection Act. In particular there exists a critical need for increased surveillance of Guam's EEZ. In order to effectively increase enforcement, Guam requires capacity building, training and monitoring vessels.

Priority Level: Low

Time Table: 18 months

Cost Estimate: \$100,000 for Purchase of Enforcement Vessel

Accountability: Division of Aquatic and Wildlife Resources, Guam Department of Agriculture

OBJECTIVE 3: Promote an Ecosystem Approach in Fisheries Management, Climate Change Adaptation and Mitigation, an Regional Cooperation

General Strategy: Support efforts to help coordinate fisheries conservation and management and address impacts from climate change within an ecosystem, including active participation in the Western Pacific Regional Fisheries Management Council, the Western and Central Pacific Fisheries Commission, the Secretariat of the Pacific Community, Forum Fisheries Agency, and other international and regional organizations.

Project Strategy 3.1 Longline Permit, Reporting, and Quota Utilization Program to Facilitate Responsible Fisheries Development

Background:	Guam is a participating territory in the Western and Central Pacific Fisheries Commission (WCPFC), which recently established longline quotas for bigeye tuna in the WCPO. As a participating territory, Guam afforded the right as a Small Pacific Island Developing State to utilize its quotas to responsibly develop its own domestic fisheries.
Description:	Funds will be used to develop a permit, reporting, and/or quota transferability program that will utilize Guam's quota allocations established under the WCPFC. Funds may also be used in the development of the program to identify, develop, and establish partnerships or arrangements for Guam's quotas to be utilized by U.S. fishing or foreign vessels in exchange for funds or training assistance to responsibly develop Guam's fisheries.
Priority:	Medium
Time table:	36 months
Cost Estimate:	\$100,000
Accountability:	Government of Guam, Western Pacific Regional Fishery Management Council, National Marine Fisheries Service
Evaluation Criteria:	Development of permit, reporting, and/or quota transferability program to facilitate funding and training for fisheries development in Guam as well other projects listed in this MCP.

OBJECTIVE 4: Public Participation, Education and Outreach, and Local Capacity Building

General Strategy: Support activities to produce videos and audio programs on the importance of fisheries, public involvement, and community-based management; print ads and articles to inform the public on upcoming meetings or issues; create lunar calendars, brochures, flyers, displays, and exhibits to inform the public; develop school curricula and educational resources of for student courses on issues related to marine resource management.

Project Strategy 4.1 Marine Conservation Public Education Campaign

Background: The purpose of this project is to collect, synthesize and disseminate adequate and accurate information in support of sound policy development on marine resource use, addressing present needs as well as concerns for future generations in Guam.

Description:	Support the development and distribution of appropriate educational, extension, and informational materials, especially in forms and formats for use by educational institutions, local groups, villages, businesses and governments focused on development of sustainable economic alternatives in the use of ocean resources. This project will be conducted through the Marine Resources Pacific Consortium, University of Guam, in conjunction with the Pacific Island Network of the University of Hawaii Sea Grant Program.
Priority:	Medium
Time table:	36 months
Cost Estimate:	\$5,000
Accountability:	University of Hawaii Sea Grant Program and University of Guam Sea Grant Program
Evaluation Criteria:	Development and distribution of public information materials promoting sustainable use of ocean resources.

Project Strategy 4.1 & 6.1 Education Component in the School for Marine Fisheries Program

Description: The 2017 Guam Marine Conservation Plan contains six conservation and management objectives. Objective 4 is “Public participation, education and outreach, and local capacity building.” Objective 6 is “Recognizing the importance of island cultures and traditional fishing practices and community based management.” Micronesia Archaeological Research Services, Inc. (MARS) is in a good position to conduct a project that will meet these objectives.

MARS is a scientific and educational non-profit corporation, incorporated on Guam in January 1992. Education is part of the mission of MARS, and the MARS archaeologists frequently give presentations at the University of Guam, Guam Community College, public and private schools, and for other organizations and events as well.

Marine Resource Use is the specialty of Judith R. Amesbury, who is one of the founders and directors of MARS. In 2005, MARS obtained a grant from the Pelagic Fisheries Research Program (PFRP) at the University of Hawaii to research pelagic fishing in the Mariana Archipelago. Amesbury and Hunter-Anderson produced a lengthy report, which is available on the PFRP website <http://www.soest.hawaii.edu/PFRP/pdf/MARSreport.pdf>, and Amesbury published an academic paper in Australia, available at

http://www.soest.hawaii.edu/PFRP/reprints/AmesburyTerra_Australis392013.pdf.

In 2010, MARS obtained grant funds from four federal and local sources in order to study “Traditional Fishing on Guam.” Amesbury produced a booklet with that title, and ten thousand copies were printed. Half of the booklets went to Guam Preservation Trust to donate to the Guam public schools and half were distributed at public events on behalf of the Western Pacific Regional Fishery Management Council. As part of the same project, a 30-minute film was also produced. The film has been shown many times in classrooms, conferences and on television.

Other Marine Resource Use projects by Amesbury have resulted in another booklet and a website (www.natonbeachguam.com), as well as two displays. See MARS Previous Educational and Public Outreach Projects (below).

Priority: Low

Time Table: 24 months

Cost Estimate: MARS is proposing to produce two new booklets and to reprint the “Traditional Fishing on Guam” booklet. These products meet both Objectives 4 and 6 in the in the MCP.

1) Over the years, Amesbury has conducted interviews with numerous fishermen in Guam, Rota, Tinian and Saipan. These interviews could be prepared for publication and turned into an informative booklet entitled “*Peskadot Marianas: Fishermen of the Mariana Islands*”. Estimated cost of creating the booklet and printing 10,000 copies is \$45,000.

2) Although the lengthy report and academic paper about Pelagic Fishing are available on the PFRP website, there is no booklet similar to the Traditional Fishing booklet available to the public. Estimated cost of creating the booklet “Pelagic Fishing in the Mariana Archipelago” and printing 10,000 copies is \$45,000.

3) There is a need for more copies of the “Traditional Fishing on Guam” booklet and film. Those products could be reproduced relatively inexpensively. Another 10,000 copies of the booklet, plus additional copies of the film, would cost an estimated \$10,000.

All of these products would be made available to the public for free. The products would be distributed to the schools, and they would be made available to the general public at presentations and public events that

celebrate the history and culture of the Mariana Islands, such as *Gupot Fanha'aniyan Pulan CHamoru* (Chamorro Lunar Calendar Festival).

This project could be broken into two years with Product 1 produced in the first year and Product 2 produced in the second year. Amesbury will continue to seek other funding for Product 3 as that is needed now.

Accountability: Micronesian Archaeological Research Services, Inc. (MARS)

Evaluation Criteria: Publication of the following booklets: “*Peskadot Marianas*: Fishermen of the Mariana Islands”; the “Pelagic Fishing in the Mariana Archipelago” and the “Traditional Fishing on Guam” booklet and film. Development and distribution of public information materials promoting sustainable use of ocean resources.

OBJECTIVE 5: Domestic Fisheries Development

General Strategy: Conduct activities that assist communities in developing their fisheries, including training, supporting new or improvements to boat harbors, piers, boat ramps, and construction of cold storage and fish processing facilities, fish markets, the procurement of ice making machines, product transportation, vessel designs, training vessels, and fishing gear.

Project Strategy 5.1 Rehabilitation and Improvements Agat Small Boat Marina Dock B

Status Update: Agat Marina Docks A, C, and D, were completed, however, Dock B is in need of rehabilitation. In addition, the fuel pier servicing the marina’s boats and well as the marina’s boat ramp loading pier is in need of repairs and replacements.

Description: Agat Marina is located in the village of Agat on the west coast of Guam near Gaan Point. It is a small boat harbor (often called Agat Small Boat Harbor) that was excavated from a coral reef flat and is protected by a detached breakwater. The boat harbor basin construction was completed in 1989 with contributions from the U.S. Army Corps of Engineers and the Port Authority of Guam. Shore side facilities were completed in 1990. The USACE describes the site as, “The project consists of an entrance channel 930 feet long, 120 feet wide, 14 feet deep; a turning basin 120 feet long, 150 feet wide, 7 to 11 feet deep, a main access channel 500 feet long, 75 feet wide, 9 feet deep; two breakwaters 985 feet long and 50 feet long, respectively; and two revetted moles 180 feet long. The protected basin provides berthing areas for up to 150 boats.”

The floats are manufactured by Meeco and are constructed of timber decking and whalers, polyethylene flotation tubs, and vinyl fenders. Steel pipe guide piles are used to secure the floats in position. The marina consists of four docks, numbered A, B, C, and D. The main walks are 7-foot-wide and the finger floats are 3-foot-wide. Utility services include potable water (double hose bibs at slips) and electrical power (Midwest receptacles). Guide piling consist of 9-inch diameter painted and concrete-filled steel pipe piles. The fixed guide piles are not tall enough to prevent the docks and guides from floating above them and breaking free during a typhoon event.

The boat basin also includes a wide concrete boat ramp, a concrete fuel and loading dock. Upland facilities include a parking area for vehicles and vehicle/boat trailer combinations, and administration office, and a restaurant.

Need:

The Agat Marina is one of only two public small-boat marinas, which support the island's estimated 817¹ boaters (Guam Police Department, Boat Registration Statistics, December 20, 2016). In addition, the marina was seen as a means of stimulating growth in boating activities with emphasis in fisheries, allowing improved access to fishing grounds in the south, addressing the demand for permanent dockage space, providing additional safe harbor in bad weather, and facilitating search and rescue activities for the area.

The conditions of Dock B have deteriorated further and structurally unsafe that requires demolition and removal of Dock B. In addition, as observed previously, the concrete fuel pier and loading dock is damaged and unsafe for vehicular traffic. Access is gated and signed as unsafe.

Priority Sequence:

- Renovation of Dock B
- Conduct A/E Design and Structural Assessment for the repair of the refueling pier and boat ramp loading pier
- Replacement and repair refueling pier and boat ramp loading pier

Priority Level:

High

Time Table:

24 months

Cost Estimate:

\$1,000,000 for Repairs to Dock B
 \$200,000 for A/E Design and structural assessment for the repair of the refueling pier and boat ramp-loading pier
 \$1,500,000 for Repair and Construction of Refueling Pier Repair and Boat Ramp Loading Pier

Accountability: Port Authority of Guam

Evaluation Criteria: When repairs and structural assessment are complete to the Agat Marina, it permits safe access for anglers to access the loading pier, access their boats, and allow access to fishing grounds in the south.

Program Strategy 5.2 Accessibility for Fishermen - Eastern and or Northern Boat Ramp

Background: In 2006, a boat ramp at Agfayan Bay in the municipality of Inarajan was constructed to provide an additional alternate ramp facility for fishers accessing the eastern or northern coast of Guam to enhance their fishing opportunities. The Inarajan boat ramp was constructed by the Guam Power Authority as a requirement for compensatory mitigation.

Unfortunately, after less than five (5) years, the Inarajan boat ramp fell into disrepair being in a high surf energy location and lacking protective barriers from the pounding waves of the sea. Agriculture's Participation Survey, which does vehicle-trailer counts, recorded few but promising and progressively growing activity of trailered boaters using the facility.

The Ylig Bay boat ramp near the mouth of Ylig River on the east side of the island provided offshore fishermen the opportunity to launch their boats to fish on the east or north side of the island. However, with the start of the reconstruction of the Ylig Bridge in March 2011, the makeshift Ylig Bay boat ramp was officially closed for recreation water use on March 14, 2011. Now that the Ylig Bridge has been completed, the Ylig Bay boat ramp has been closed indefinitely.

In addition to the lack of and concerns with the Inarajan and the Ylig Boat Ramps, the northern side of the island also does not have any accessible boat ramps for use by offshore fishermen. The lack of a boat ramp is a growing concern for fishermen and boaters, especially in terms of mitigating the time it takes for rescue personnel to respond to calls of distress or other emergency situations by fishermen, boaters and for any other ocean water situations. Responding to emergency calls from our neighboring islands of Rota, Tinian and Saipan is also a matter of concern to take into consideration. Aside from the Hagatna, Agat and Merizo Boat Ramps, offshore fishermen from the north will have to trailer their boats to these locations in order to launch their boats in the ocean for fishing, recreational or other ocean water events or activities.

A boat ramp needs to be implemented and made accessible to Guam's fishermen on the eastern and or northern side of the island due to the

unusable condition of the Inarajan Boat Ramp and the closure of the Ylig makeshift ramp.

Description: Boating access facilities enhance fishing opportunities, but they must be placed in appropriate and acceptable areas. Impacts to private property, native species habitat, wetlands, and historic/cultural sites must be evaluated. Boat ramps should not be installed in steep slope areas, which would make the ramp hazardous and difficult to use. The ramp should be installed in an area that is usable during high and low tides. Wave prone areas may be subject to erosion and may be unusable during windy conditions. Furthermore, structures such as adequate lighting, water for rinsing and aids to navigation should be installed and maintained in order to provide a safe and enjoyable experience for boaters and recreational fishermen. A need exists to identify an area in the eastern or northern side of Guam to implement the boat ramp.

Priority Sequence:

- Feasibility Study to identify a location in the eastern and or northern side of Guam to implement a boat ramp.
- Design and Permit for the boat ramp.
- Construction of the boat ramp.

Priority Ranking High

Time Table 36 months

Cost Estimate \$950,000 for Boat Ramp (Feasibility Study \$50,000, A&E Design and Permit \$200,000 and Construction \$700,000)

Accountability: Department of Agriculture

Evaluation Criteria Feasibility study completed identifying a site to construct the boat ramp on the eastern or northern side of Guam. A&E Design and Permit for the boat ramp is completed. Construction of boat ramp is completed.

Project Strategy 5.3 Fish Aggregating Device Deployment Vessel

Background: The Department of Agriculture currently obtains a purchase order to deploy fish aggregating devices (FADs), which are floating objects that attract, aggregate and hold pelagic fish in the area, ultimately increasing the catch of fishermen. When FADs go offline, fishermen expect that the FADs will be replaced in a reasonable amount of time. The cost to deploy

a FAD is high at approximately \$20,000 per deployment with only one company currently able to deploy FADs. This high cost limits the amount of FAD deployments due to funding availability. Deployment costs have increased each year resulting in DAWR reducing the number of FAD deployments per year. Alternatives are needed to reduce the cost of deployments.

Description:	With the purchase of a FAD deployment vessel, FAD deployments can be conducted more frequently allowing fishermen the opportunity to increase their catch. With an average cost of \$20,000 for deployments, DAWR can expect a return on the FAD deployment vessel in a little over 2 1/2 years assuming a cost of \$250,000 for the vessel.
Priority Level:	High
Time Table:	18 months
Cost Estimate:	\$250,000 for Purchase of Deployment Vessel
Accountability:	Division of Aquatic and Wildlife Resources, Guam Department of Agriculture
Evaluation Criteria:	The FAD deployment vessel is purchased. FAD deployments will be conducted frequently allowing fishermen the opportunity to increase their catch and reduce the high cost of FAD deployments.

Project Strategy 5.5 Health Management of Manahak (Rabbitfish) in the Hatchery for Restocking Purpose

Background:	Rabbitfish (<i>Siganidae</i>) is a traditional and highly valued food fish in the Micronesia and Indo-western Pacific region. Approximately 16 species belonging to the genus <i>Siganus</i> are found in the waters of Micronesia (Woodland and Allen, 1977; Woodland and Randall, 1979; Woodland, 1983; 1990; Park et al., 2006). Among them, three species of rabbitfish, <i>Siganus argenteus</i> , <i>S. randalli</i> and <i>S. spinus</i> , are culturally important food fishes and have great potential for aquaculture. Although rabbitfish juveniles and adults are currently harvested from the ocean as food resources, the annual catches on Guam are declining rather than growing. Because rabbitfish serves as primary consumer in the coral reef ecosystem, restocking the improved high health stock rabbitfish to the Guam ocean and providing such stocks as the food resource for human consumption via aquaculture means would benefit the buildup of healthy marine resource habitats and protection of human health by minimizing
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the ciguatera toxicity and other possible health risk in the reef fish food chain.

Siganus argenteus demonstrated a reasonably fast growth rate and relatively high density tolerance from a small scale experiment conducted and by the Secretariat of the Pacific Community at New Caledonia (SPC Fisheries Newsletter, 2008). *S. randalli* and *S. spinus*, two closely related rabbitfish species, but smaller in maximal size than *S. argenteus*. *S. randalli* were cultured in cages with rearing information collected during a previous study conducted in 1994 at the UOG hatchery. Results indicated that *S. randalli* could grow from 9.5g to 100.2g in 85 days and with a stocking density of 44 fish/m³ in marine cages (Brown et al., 1994). In that study, a commercial catfish feed with 36% crude protein content was used. However, fish also exhibited lateral line erosion shortly after the second month, and this condition appeared to be closely associated with nutritional deficiencies. The specific nutrient deficiencies remain unknown and if such deficiencies would also affect growth and survival of *S. randalli*. In addition, a variety of infectious agents can cause health problems in rabbitfish. To prevent disease outbreaks caused by various parasites and bacterial pathogens, nutritional modulation to enhance the immune response may be a better alternative than applying antibacterial drugs and chemotherapeutic treatments. The significance of a proper diet in preserving the health of fish and other living organisms is widely recognized. Specific immuno-nutrients such as vitamin E and prebiotics have resulted not only in enhanced growth performance but also in an improved innate and acquired immune function in marine fish such as red drum and hybrid striped bass (Li and Gatlin, 2004; 2005; Burr et al., 2005, Buentello et al, 2009).

Siganidae species are usually considered to be herbivorous, and can be potentially reared using diets without fishmeal (El-Dakar et al., 2007), which would be desirable as plant protein diet could be formulated and the nutritionally complete diet to be determined for improving the rabbitfish stock health, promoting growth, maturation and larval rearing. In the meantime, the exploration of the best practices of culture system under domestication, namely, polyculture with other marine species in the ponds and cages at the hatchery. Our preliminary trial showed that the rabbitfish *S. spinus* grew much faster while being stocked in the specific pathogen free shrimp ponds than in the pond by themselves, and they were able to reach to more than ½ pound from fingerling in 2-3 months without any other special treatments. However, the nutritional requirements and culture system and techniques of rabbitfish have rarely been studied under domesticated conditions, The outcomes of proposed project could help fill

in the knowledge gaps and address the key nutritional requirements for the performance and health of *S. argenteus*, *S. randalli* or *S. spinus*, and consequently contribute to a healthier marine ecosystem by restocking the hatchery reared rabbitfish in the Guam water and protect the human health.

Description:

The specific objectives of the proposed project are: 1) to evaluate and optimize the culture systems for the three rabbitfish species in terms of growout performance, and maturation, etc.; 2) to systematically characterized key nutritional requirements of rabbitfish by choosing one experimental model among the three rabbitfish species; 3) to determine the effect selected nutrients on specific and non-specific immune response of rabbitfish; 4. to determine the effects of several prebiotic compounds on growth performance, immune responses and disease resistance of juvenile rabbitfish; 4) to identify the overall health status of the hatchery reared stock in comparison with the wild rabbitfish stock and conduct restocking.

Dr. Jiang will oversee the project. Mr. Alig will be responsible for obtaining, maintaining the stock in the hatchery for various trials and performing restocking with the assistance of hatchery staff, and UOG students. Dr. Sealy will assist in the diet formulation, diet preparation and experimental design and sample analyses.

The first year the project will be focused on the collection of the three dominant indigenous rabbitfish species from the wild, domestication, and then evaluation and optimization of the culture systems of raising the rabbitfish in the UOG hatchery, followed by a series of experiments in developing the nutritionally complete diets for the rabbitfish.

Culture systems and techniques will be explored and developed for rabbitfish aquaculture. Outdoor tank, pond, cage and polyculture options will be included for the most suitable culture systems under domestication. Water quality will be monitored and multiple water parameters will be kept within the desirable ranges for rabbitfish culture. Depending on the availability of the rabbitfish sources, single or combined species will be grouped either in the tanks or in the cages for studying the density effect and polyculture effects. Specific pathogen free *Penaeus vannamei* will be chosen as the marine species along with the rabbitfish in the same outdoor system because the preliminary study showed that no adverse effects for either shrimp or fish occurred for such polyculture. Instead, rabbitfish grew 5 times faster in polyculture those in monoculture. Performance data of the experimental marine organisms will be collected and analyzed to

decide the most practical culture regimes would be in the hatchery for rearing the rabbitfish.

Multiple feeding trials will be conducted for evaluated the energy and protein requirements, vitamin E requirement, etc. Each feeding trial will last up to 12 weeks and will be conducted in the cages in the outdoor concrete tanks in the hatchery. The 3 x 2 factorial design will be employed in which diets will be formulated to contain 25, 35 or 45% protein to provide a range that typically encompasses most marine species studied thus far and 10 or 20% lipid for the energy and protein requirements. Vitamin E deficiencies in various fish species result in muscular dystrophy, edema of heart, muscle and other tissues, anemia, depigmentation, and ceroid pigmentation of the liver. In addition, supplemental dietary vitamin E added above the requirement level has been used to improve the immune function, and to increase oxidative stability of fillets. Vitamin E supplementation will be at 0, 15, 30, 60 and 120 mg/kg diet. Growout performance and tissue samples of rabbitfish from each dietary treatment will be collected and analyzed for determination of the key nutritional requirements.

The second year of the project will assess immune responses and overall health status of the stocks and by the end the project, conduct the restocking them in the ocean after the healthy stocks are obtained. A few types of commercially available prebiotics will be used for the feeding trial conducted at the UOG hatchery in the cages maintained outdoors. Immediately following the feeding trial, gastrointestinal tract (GIT) contents from representative fish in each cage fed the various dietary treatments will be sampled to characterize potential changes in microbiota using denaturing gradient gel electrophoresis (DGGE) analysis (Li et al., 2007) and GIT morphology. Immunity indexes, such as whole blood neutrophil oxidative radical, plasma lysozyme activity, superoxide anion, will be evaluated for the health status of the rabbitfish and profiles of the wild rabbitfish stock will be compared.

Prior to restocking to the ocean, ciguatera test will be applied and DNA will be sampled in order to establish the genetic database for reliable and consistent monitoring of rabbitfish diversity on a continuous basis. The genetic analysis of these samples will help us to gain more insight on the marine ecosystem conservation and fishery management.

This project is a very exciting blend of basic research on fish nutrition and immunology with the practical goal of improving the health status of rabbitfish in general. Findings in basic science have been paralleled by encouraging results in aquaculture settings, where modulation of the levels

of specific nutrients in the diet has resulted in significant improvements in disease resistance of fish. From an applied science standpoint, the proposed research may prove fundamental to developing biotechnological strategies whereby variations in diet formulation may allow better growth and survival of cultured rabbitfish. For the fisheries and aquaculture (the stakeholder), this knowledge also may result in reduced grow-out periods and improved immune responses and health status.

Priority Ranking:	Medium
Time Table:	24 months
Cost Estimate:	\$148,000: \$80,000 in Year 1 \$68,000 in Year 2
Accountability:	University of Guam Hatchery
Evaluation Criteria:	Progress reports will be prepared and submitted to the Department of Agriculture and the funding agencies. At the end of the two-year study, one or two manuscripts will be prepared and submitted to respected scientific journals in the fields of marine aquaculture, conservation or fisheries research. All data will be accessible to the public, government agencies and scientific community.

Project Strategy 5.6 Capital Financing - New Guam Fishermen's Cooperative Marina Building Complex

Background:	The Guam Fishermen's Cooperative Association presently has 200 members and is a 36 year old non-profit organization whose mission is to market the fish harvested by its members who are considered "artisanal fishermen". The Guam Fishermen's Cooperative Association's present facility has insufficient space. A new structure at the Hagatna Boat Basin is needed to house the Coop's retail outlet, office and processing and ice facilities along with a restaurant that exclusively sells seafood from the Coop, marine related gift shops, dive and tackle shops and other marina related businesses. An Architectural and engineering design plan for the facility has been completed.
Description:	The financing for new Guam Fishermen's Cooperative Marina Building Complex was proposed in prior Marine Conservation Plans, however, funding was not identified. Through the Guam Hotel and Occupancy Tax, funding was made available for the following two phases. The project is designed in three phases.

Phase I is the construction of a 240 feet seawall the length of building to the Pillhouse Bunker.

Phase II is the construction of the first-story facility that will include the Co-op Fish Market, Coffee Shop and Dive/Gift Shop. A ground breaking ceremony for planned construction took place on January 28, 2017.

Phase III will encompass the second-story floor to include the restaurant, office space, meeting lanai, a fisheries museum and a conference/classroom area. Included in this phase is the securing of all federal and local permits. Funding for this phase has not been identified and is proposed in the 2017 Marine Conservation Plan.

Priority:	High
Time table:	36 months
Cost Estimate:	\$3,500,000
Accountability:	Guam Fisherman's Cooperative Association
Evaluation Criteria:	The construction of the facility and further expansion of Guam's fishery economic base through increased income revenues for Guam's commercial and recreation fishermen.

Project Strategy 5.7 Fish Aggregating Devices and Shallow Water Mooring Buoys

Background:	A fish aggregating device (FAD) is a floating object that attracts aggregates and holds pelagic fish in the area, ultimately increasing the catch of fishermen. When FADs are offline, fishers call DAWR to report problems with the FAD and to request the FAD be replaced. The project also involves enhancement projects such as the production of FAD location maps for recreational fishermen and the improvement of the current FAD system designed to extend the average time on station. The cost of FAD deployment has doubled and now costs approximately \$20,000 per deployment. This cost does not include the cost of purchasing components.
Description:	A total of fourteen (14) FADs are part of DAWR's fish aggregating device program. Missing FADs are either determined by aerial surveys or by fishermen who report missing FADs. The purchase of equipment, supplies and materials to deploy FAD systems at various depths in addition to contracting companies to deploy FAD systems for those that are missing

will ensure existing FADs are redeployed for year-round sportfish use. Presently, DAWR has federal funds under the Dingell-Johnson Sports Fish Restoration Fund that can be used to deploy new FADs in addition to replacing FADs that are either missing or not operable.

DAWR currently has a total of thirty-four (34) SWMs that are a part of its mooring program to minimize anchoring damage to Guam's coral reefs. Missing SWMs are either determined by aerial surveys or by boaters calling in to report missing SWMs. The purchase of equipment, supplies and materials, contracting companies to deploy SWMs for those missing and involving commercial companies willing to install SWMs will ensure existing SEMs are available for year-round sport fish use.

Priority Level: Medium

Cost Estimate: \$100,000. Funds will be used to supplement funding that is available through the Dingell-Johnson Sports Fish Restoration Fund and other funding sources that are available for the deployment and replacement of FADs and SWMs.

OBJECTIVE 6: Recognizing the importance of island cultures and traditional fishing practices and community based management

General strategy: Support projects identified and consistent with the Western Pacific Community Development Program, Western Pacific Community Demonstration Program, Western Pacific Marine Education and Training Program or other community programs that promote the management, conservation, and economic enhancement of communities in Guam as well as to promote traditional and indigenous fishing rights, practices, and management approaches.

Project Strategy 6.1 Chamorro Traditional Fishing

Description: For centuries the people of Guam and Northern Marianas have relied on the ocean and water system as a life sustaining force. The ocean has shaped our Pacific Island Identity. We have a rich history of traditional fishing knowledge and other cultural skills that persist among small circles, but the changing tide and life style associated with westernization and modernization have noticeable consequences. Guam is a small island covering an area of 212 square miles. Guam is about thirty-two miles in length, with a width of 4 to 8 miles. To the east lies the Marianas Trench and Challenger Deep, the deepest spot on earth. To the western trough lies an active spreading center with hydrothermal vents and fascinating chemosynthetic communities. The beaches and water systems are important natural resources that contribute greatly to the community, both

economically and culturally. Fishing skills play an important role in many of our Pacific Islanders cultures and are central to our indigenous way of life. As our community continues to evolve and adopt western practices, many of our youth are unable to demonstrate both traditional skills in fishing and other basic cultural activities. Traditional fishing methods and basic cultural skills are being lost to our youth and too few educational outlets exist to promote and pass down traditional knowledge to them. The objectives are:

- To provide non-formal education workshops, awareness, and demonstration sites to promote Guam traditional fishing methods.
- To provide an educational enrichment program in traditional fishing methods to middle and high school students.
- To provide a series of demonstrations and public awareness at selected sites on Guam to promote hands-on learning activities for the teaching of traditional fishing techniques.
- To provide the local youth with the opportunity and skills to be more effective in traditional fishing methods and traditional conservation.
- To create collaborative partnerships with local agencies and Master traditional fishermen for the promotion and sustainability of traditional fishing methods.

Priority:	High
Time Table:	12 Months
Cost Estimation:	\$60,000
Accountability:	University of Guam Youth Development 4H Program
Evaluation Criteria:	Pre and Post evaluation will be an instrument to measure knowledge. Data sheet for number of participants, number of fish tagged and retrieved.

Project Strategy 6.1 & 6.2 Improving Relationships between Resource Managers, Local and Migrant Fishermen

Background: Beginning in 2007, Guam has seen an increase in the amount of fishing activity by recent migrant citizens, primarily from the Federated States of Micronesia (FSM). One of the effects of this fishing activity has been an increase in conflicts with local fisherman, as well as local resource managers. These conflicts include perceived trespassing; novel fishing methods that may be illegal; violations of the MPAs and other laws regarding marine organism take, both out of ignorance of the laws, as well as willful violations; a lack of safety while at sea; and the rise of

commercial fishery consisting of these fishers and stores that purchase fish from them.

Over the last decade there has been a deterioration of the relationship between local fisherman, migrant fisherman, the indigenous advocates, local and federal government professions, local policy makers and critical stakeholders. Before we can address building the relationship between these various stakeholders, the Department of Agriculture, Division of Aquatics and Wildlife Resources would like to address the concerns from the local community related to fishing practices among our FSM fishing community, especially the Chuukese community.

Description:

The project will aim to develop a closer relationship with the Chuukese community, the largest migrant population from the Freely Associated States of Micronesia, through an effective targeted public outreach and education campaign. The issues to be address through this project will include, Guam fishing and MPA laws and regulations, rules and regulations of the different MPAs, size and catch restrictions, cultural differences between Chamorro and Chuukese fisherman regarding fishing boundaries, safety concerns, spearfishing practices, commercial verse noncommercial sales, and other critical issues that have cause conflict among local and Chuukese fishermen.

The targeted educational campaign will include developing printed material in both English and Chuukese with messages that are culturally appropriate, producing video and radio public service announcements as well as using other traditional and social media formats that can get the messages out to the targeted community.

In addition to the materials being produced for this campaign, at least two workshops lead by local Chuukese government, traditional and religious leaders will be conducted. These workshops will be opportunities for sharing of information in fellowship. These workshops will be held in areas where communities gather including religious events. In the Chuukese culture, church functions are the most appropriate venue to obtain information and receive material. DAWR will also partner with the Governor's Community Outreach Program, Micronesian Resource Center One Stop Center to distribute material to the Chuukese communities around the island. The Micronesian Resource Center One Stop Center has a van that travels around the island to assist Micronesian migrant communities with public services that are available. DAWR will provide all the material from the project for distribution. DAWR will also partner with local fish shops to distribute materials produced by this project.

During year two, a workshop is planned within various partners to discuss the effectiveness of this effort and lessons learned. These lessons will be shared with other Micronesia migrant communities. The goal of the workshop is to learn what works and what doesn't when communicating with the various migrant populations on the island. It will also provide opportunities for fisheries personnel to more effectively combine local customs, traditional knowledge and scientific knowledge to effectively manage Guam's limited resources.

During year two, the PI will work with the various high school students interested in working with Micronesian communities in educating them on appropriate practices for fishing on Guam. As part of a service learning project, students will participate in community outreach activities and distribute material, share information with families and engage with sectors of the population that DAWR traditionally has limited interaction.

The overall outcome of this project is to improve relationships between resource managers, local fisherman and recent migrant fisherman on Guam. In addition, the outcome of this project is to increase the educational awareness level of Chuukese residents on Guam to enact positive behavioral changes for those affecting the reef through appropriate fishing practices. Through this effort, it is expected that a better relationship will be developed between the Chuukese fishing community and the rest of the local fishing community.

It is expected that this targeted campaign will serve as a pilot project for all other migrant communities on Guam. If successful it is expected that the project will be expanded to other communities such as the Filipinos, the Palauan, the Yapese, Pohnpeians, Chinese, Korean, etc.

Priority Ranking	High
Time Table	24 months
Cost Estimate	\$19,000 estimated cost. Products produced by this project will include multiple items including printed pamphlets, posters, online media, magnetics, pens, tee shirts, workshop materials, and radio and newspaper advertisements to support the targeted messaging campaigns.

Budget Justification: Contract cost include printing for materials for public outreach events, cost for logistics and facilitation for an outreach workshop, media cost including advertisement and airing of PSAs.

Supplies

Workshop materials – pens, notepads, markers, etc. - \$1,000.

Contractual

Media: Production and airing of PSAs, print ads, radio and television time to advertise workshops, etc. Budgeted amount is based on similar needs for other projects - \$5,000.

Printed materials: Printed materials including translation for pamphlets, posters, flies stickers, etc. for distribution to the local Chuukese fish shops, Chuukese fisherman, and for use at the workshops, and for distribution to Governor's Outreach Program for Micronesian communities. Some promotional items will be produced in conjunction with this effort - \$10,000.

Workshop support: Room rental and other costs to provide a venue for the workshop - \$1,000.

Accountability: Department of Agriculture

Evaluation Criteria This project is focused on developing effective messages and material for education and outreach targeted at the Chuukese community about appropriate fishing practices and the threats to coral reefs. The activities to achieve this goal include the following:

- Developing appropriate printed material in both English and Chuukese. The PI will work with local Chuukese fishermen on in developing appropriate messages regarding perceived trespassing, Guam fishing laws, catch limits, violations of MPA and other laws regarding marine organism take, and safety at sea. Most of the background information is readily available; however, the material will need to be updated in a way that will be understood by local Chuukese fisherman. The material will also be translated into the Chuukese language.
- Develop appropriate social media, video and radio Public Service Announcements to accompany the printed material. In addition, collateral material such as magnetics, tee shirts, pens, etc. will be developed for this project and for future use. This will be available for community groups to use for various events as well as to be posted on social media platforms.
- Provide a minimum of two workshops at the appropriate Chuukese community functions. These workshops will be led by local Chuukese leaders and staff from the DAWR. This will be an informal format to start the discussion and to build a relationship between the Chuukese

fisherman and the DAWR. After the workshops, some follow up work will be conducted to response to the Chuukese fishermen's concerns, to provide additional materials and provide assistance as needed.

- The PI will also coordinate with the Micronesian Resource Center One Stop Shop to provide appropriate materials for distribution.
- During year two, a general workshop with all stakeholders will be conducted to discuss the impact from the project and the effectiveness of the material that were produced.
- During year two, the PI will work with the various local high schools in getting students involved in educating their community on appropriate fishing practices. It is hope that service learning project can be developed with all the other Micronesia residents. Along with the DAWR staff, students will participate in at least two community events to distribute material and engage with local Micronesian communities and obtain feedback that can strengthen and improve the relationship between Micronesian fishermen and Chamorro fishermen.

Project Strategy 6.2 Discovering the Cultural Importance of Fishing Techniques through Associated Indigenous Linguistic Practices

Description: Indigenous fishing techniques develop and survive within an indigenous linguistic context. Hence, preserving culturally important fishing methods also requires documenting and understanding the detailed technical language required by indigenous fishers. An in-depth linguistic approach is also critical to discovering fishing techniques known only to a small and, sadly, a shrinking cadre of indigenous experts. For example, some fishers on Guam built rock shelters (*guma' acho'*) on shallow and otherwise barren reef platforms to concentrate fish for spearing. This interesting technique has potential for wider use in conserving and managing Guam's fish stocks, but it has not been reported in any historical or modern published account of fishing in the Mariana Islands and is unknown outside of the few families who practiced it. We are also aware of several other techniques that are known by only a few remaining living practitioners. Discovery of these rare techniques came about only via extensive interviews with indigenous fishers when granted their permission to accompany them in their fishing activities, which has been invariably conducted using a technical vocabulary that is exclusively Chamorro.

The first phase will be the identification of the types of traditional fishing methods that continue to be employed for inshore harvesting, and the level of decline in the application of the methods. A comprehensive inventory of technical terminology accompanying indigenous fishing on Guam to

aid will be conducted in 2) uncovering little-known techniques in danger of being lost because they are practiced by only very few traditional fishers. The later phase will include those techniques no longer practiced, but which are known by older living practitioners or which lie recorded in early historical documents. These phases will be accomplished through 1) interviews conducted in Chamoru with native speakers possessing expert knowledge of past and present indigenous fishing methods, 2) a survey of historical documents beginning with European contact and 3) dissemination of translations and analyses via reports available to relevant agencies and the public, as well as multimedia productions freely available to educators.

Priority level:	Low
Time Table:	24 months.
Cost estimate:	\$35,000 per 12-month period
Accountability:	University of Guam.
Evaluation Criteria:	Dissemination of translations and analyses via reports available to relevant agencies and to the public via the internet and multimedia productions freely available to educators.

Project Strategy 6.3 Preservation of Traditional In-shore Fishing Practices

Background:	Traditional in-shore fisheries practices are being displaced by the utilization of modern gear and methods, and there are indications that traditional fishing knowledge is already becoming scarce. While there are several programs designed to provide practical training and create an appreciation for fishing among Guam's youth and the community in general, there are no specific programs which are geared toward the preservation of traditional fishing methods. This program strategy is proposed in two phases. The first phase is to identify the types of traditional fishing methods that continue to be employed for inshore harvesting, and the level of decline in the application of the methods. The second phase would apply these findings in the development of preservation programs.
Description:	Phase I: Statistical Profile of Existing In-shore Traditional Fishing Practices. The DAWR conducts in-shore creel surveys which provide data to include fishing location, species caught, gear used. The data sets reflect consistent surveys from 1985 to present. In addition, the GFCA conducts

in-shore volunteer data surveys. In-shore data can be extracted from these two sources and be analyzed to provide a comparison on the level of gear utilization for activities classified as traditional fisheries, and provide a comparison on the level of application of traditional fishing practices in comparison to other fisheries activities, covering the time period of the data base.

Phase II: Development of Community Oriented Apprenticeship Programs for Traditional In-shore Fishing Practices. Create a Master Traditional Fisherman program within the Guam Council on the Arts and Humanities. Develop criteria for qualifying masters. Conduct community outreach to identify and archive Guam residents who possess traditional fishing knowledge, to include gear used, gear manufacturing and repair techniques, and other information necessary to preserve and convey the practices. The master program would also establish an apprenticeship curriculum that would include the identification of individuals to do teaching, length of apprenticeship, technique(s) to be applied, and number of apprentices. Stipends would be made available to both teachers and students based on length of time required to accomplish program and materials required.

Priority Level:	Low
Time Table:	Phase I - 3 months Phase II - Continuous
Cost Estimate:	Phase I - \$10,000 Phase II - \$50,000 annually
Accountability:	Phase I: Guam Fishermen's Cooperative Association (should the proposed marine biologist under the Guam Volunteer Fishery Data Collection Project be funded, the biologist will assist the GFCA with the implementation of this Phase) Phase II: Guam Council on the Arts and Humanities
Evaluation Criteria:	Phase I - Completion of statistical analysis of traditional fishing practices and identification of existing activities Phase II - Implementation of Master of Traditional Fisherman Program.

4. OTHER MARINE CONSERVATION SUGGESTED OBJECTIVES

This section reviews those objectives suggested by the Council's PIAFA Working Group that were de-emphasized in the development of Guam's first 1999 MCP. They continued to be recognized in Guam's 2005 and remain recognized in this plan too. If conditions change they may be reconsidered for inclusion in future plans.

4.1 Data Collection and Reporting

Fresh fish enter the commercial market in Guam from three sources: full-time commercial fishermen, part-time commercial fishermen and subsistence or recreational fishermen who sell portions of their catch. Before the Guam Fishermen's Cooperative Association (GFCA) was established in July 1979 there was no central place to sell fish. The Coop subsequently became the primary distribution center for fresh local fish. In 1982, WPacFIN began working with the Coop to improve their invoicing system and to obtain data on all fish purchases on a voluntary basis. A cooperative fishery data collection system was established. Data from two other fish wholesalers were collected beginning in 1983 and continued until their closing in 1987. Presently, the Guam Fishermen's Cooperative Association is the primary source for data collection efforts for Guam based commercial, recreational and subsistence fishery activity.

Monthly and annual summary reports of commercial landings data are generated by GFCA. Data are summarized in tables containing information on the pounds landed, value and the average price per pound for each species or species group.

The Bureau of Statistics and Plans collects landing information from vessels which transship fish through the port of Guam. In general, foreign long line vessels offloading in Guam have maintained good landings records. Data collected by the Bureau of Statistics and Plans include vessel size; vessel name, flag and type; offloaded tuna and billfish by species weight, value and destination of catch; fish transshipment by species; exporting agent; mode of transportation and destination; and vessel agent listing. In 2016, a total of 16 vessels made 106 Port-of-Calls, offloading 1313.5 metric gross tonnage of fishes. Marine fisheries big eye and yellow fin tuna continue to make up the largest catch followed by blue marlin, swordfish and black marline. The following table provides a ten year breakdown of tuna offloaded in Guam by species from the Transshipment Summary Data (in metric ton) from CY 2006 - 2016.

ANNUAL REPORT ON TUNA OFFLOADED IN GUAM BY SPECIES											3/17/2017
SOURCE: TRANSHIPMENT SUMMARY (In Metric Ton). DATA FROM: 2006 - 2016											Table 1
CY	POC * VES	BET	YFT	ALB	BEM	BKM	SWO	OTH	OTN	OTC	TOT
2006	572 * 100	3589.4	2498.1	95.3	179.8	129.1	52.5	6.4	18.7	6.4	6575.7
2007	502 * 97	3449.5	2135.3	25.1	179.3	152.3	43.8	3.6	4.8	10.5	6004.2
2008	404 * 86	3113.4	1073.4	24.3	146.1	76.4	34.4	1.7	8.9	12.9	4491.5
2009	268 * 67	1826.6	949.9	5.2	59.6	31.0	25.6	0.0	4.5	1.6	2904.2
2010	186 * 32	987.6	715.2	23.2	98.2	36.6	34.9	0.0	0.1	1.8	1897.8
2011	168 * 23	1343.4	532.0	22.0	53.5	36.3	19.2	0.8	0.0	9.4	2016.6

ANNUAL REPORT ON TUNA OFFLOADED IN GUAM BY SPECIES											3/17/2017
SOURCE: TRANSHIPMENT SUMMARY (In Metric Ton). DATA FROM: 2006 - 2016											Table 1

CY	POC * VES	BET	YFT	ALB	BEM	BKM	SWO	OTH	OTN	OTC	TOT
2012	214 * 28	1690.3	501.0	29.0	78.3	3.0	45.8	0.0	3.6	58.0	2408.9
2013	202 * 24	1379.5	435.8	47.7	103.1	0.0	49.7	0.0	0.6	30.5	2047.0
2014	189 * 26	1854.5	291.6	19.9	58.9	0.1	48.1	0.0	0.7	15.7	2289.5
2015	174 * 23	1358.3	597.8	46.2	44.5	0.0	24.2	0.0	0.7	21.2	2092.9
2016	106 * 16	685.0	566.5	2.8	26.9	8.5	19.6	0.0	1.1	3.1	1313.5
Total	2985 * 522	21277.5	10296.8	340.8	1028.2	473.3	397.8	12.5	43.8	171.2	34041.8

Note: BET:Bigeye; YFT:Yellow Fin; ALB:Albacore; BEM:Blue Marlin; BKM:Black Marlin; SWO:Swordfish; OTH:Other; OTN:Other Non Tuna; OTC: Other Species Combined; TOT: Total.

Source: Bureau of Statistics and Plans, Planning Information Program, 2017

5. List of Abbreviations

BSP	=	Bureau of Statistics and Plans
Council	=	Western Pacific Regional Fishery Management Council
DAWR	=	Division of Aquatic and Wildlife Resources, Department of Agriculture
EEZ	=	Exclusive Economic Zone
FEP	=	Fishery Ecosystem Plan
FSM	=	Federated States of Micronesia
GEDA	=	Guam Economic Development Authority
GFCA	=	Guam Fisherman Cooperative Association
MCP	=	Marine Conservation Plan
MSA	=	Magnuson-Stevens Fisheries Management and Conservation Act
NMI	=	Northern Mariana Islands
NMFS	=	National Marine Fisheries Service, US
NOAA	=	National Oceanic and Atmospheric Administration, US
NOS	=	National Ocean Survey (NOAA), US
PIA	=	Pacific Insular Area
PIAFA	=	Pacific Insular Area Fishing Agreement
Secretary	=	U.S. Secretary of Commerce
SPC	=	Secretariat of the Pacific Community
UOG	=	University of Guam
USCG	=	United States Coast Guard
VMS	=	Vessel Monitoring System
WPacFIN	=	Western Pacific Fishery Information Network